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EARLY TERRESTRIAL CONDITIONS THAT MAY HAVE FAVORED ORGANIC SYNTHESIS

THERE is a wide gap between the inorganic carbon compounds, as we now know them in nature, and the much more highly complex carbon compounds which are the material basis of living beings. It is a prevalent view that this gap can not be bridged by natural processes under existing conditions. On the face of things this view seems to be supported by the testimony of experience. This experience, however, when critically examined, is not altogether conclusive. Even if it could be shown beyond question that the chain of carbon compounds necessary to bind the inorganic to the organic never is built up under present conditions, there would still remain a legitimate ground of doubt in the possibility that this may be due to predaceous plants and animals, especially bacteria, which attack the carbon compounds at the first stages at which they become available for food and thus cut off the evolving series before it is complete. In this it is assumed that the formation of the more complex carbon compounds can come about only as the result of a long series of synthetic steps, and that at some of these stages, probably at many of them, the products would be suitable food for existing beings, especially for the almost omnivorous and ubiquitous bacteria. This prolonged evolution may thus be regarded as an extremely precarious process in the presence of predatory organisms; may indeed be regarded as practically prohibitive

after the earth was once well planted with the rapacious varieties. This adverse contingency obtains quite irrespective of the theoretical possibility of such an evolution under favorable conditions, if left undisturbed.

A further element should not be overlooked. Before an organic series can be permanently assured, the power of self-propagation must be acquired. What may be the contingencies attending the addition of the self-propagating function to the acquisition of the requisite chemical constitution is at present quite beyond determination. There may be in this supplementary process, if indeed it be a supplementary process, as great a liability to predatory arrest, as in the chemical synthesis itself. Probably the safest answer which the extreme evolutionist can give to the suggestive question why wholly new orders of living beings have not appeared at frequent intervals in the geologic record, lies in an appeal to the rapaciousness and universality of the attack of organisms already present.

It is merely as a matter of precaution that these considerations are cited here. It does not seem to us safe to make the unqualified affirmation that present terrestrial conditions are wholly incompatible with the natural synthesis of a series of carbon compounds linking the inorganic to the organic if the whole predaceous kingdom were removed so as to leave the organizing agencies unlimited opportunities for interaction for an indefinite period. The purpose of this paper is not to meet a geologic necessity, but merely to consider those conditions in the early history of the globe which may be thought to have been specially favorable to organic synthesis, irrespective of the question whether the natural evolution of life was wholly dependent upon them or was merely facilitated by them. The paper is not the result of an inquiry into the problem of organic synthesis, as such, but is rather a preliminary statement of supposed geologic conditions intended to suggest inquiry in certain lines which do not seem to have been critically pursued. At the same time, the treatment may serve to connect with this chiefest of synthetic problems the postulates of the planetesimal hypothesis which have been little discussed in this regard.[1] Only a part of the agencies herein suggested as bearing on the synthetic process are however peculiar to this hypothesis. In some notable part they are assignable to any mode of origin which the earth may reasonably be supposed to have had.

The growth of the earth by the planetesimal method leaves a rather wide speculative range relative to the conditions which prevailed at the stage when life was introduced. At the same time, the hypothesis recognizes limitations which shut out certain conditions that have sometimes been thought to be important to the evolution of the higher carbon compounds, notably high atmospheric pressure. Under the older cosmogonies very high atmospheric pressures associated with very high temperatures were postulated. Under the planetesimal hypothesis, it is indeed possible and logical to assign to the atmosphere as great an extent and as high a pressure as the gravity of the earth can control; but the hypothesis, as we hold it, is built on the assumption that molecular activities limit the atmosphere, a principle which, if true, limits it under any hypothesis. If the doctrine of Stoney, modified to meet the new advances in physics, is sound, it can not, of course, be violated by any cosmogonic hypothesis without self-destruction. If this doctrine is true, and the earth-mass lacks power to control an

[1] Chamberlin and Salisbury's "Geology," Vol. II., 1906, pp. 111–116.

atmosphere radically greater than the present one, it is obvious that the notion of an atmospheric pressure appreciably greater than the present should not be entertained. It is because this doctrine of Stoney is believed to be fundamentally sound, subject to some qualifications, that the planetesimal hypothesis has developed its postulates in consonance with it and has not consciously entertained assumptions regarding sequential states that are at variance with it. If the doctrine of Stoney is sound, the gaseous and gaseo-meteoritic hypotheses have no advantage as to the pressures of the early atmospheres; on the contrary, the higher temperatures they assume imply greater molecular activity and hence greater molecular losses and less pressures than prevail around the present relatively cool earth. In this paper, therefore, no appeal will be made to *general* atmospheric pressures appreciably greater than the present; indeed, we shall try to be true to the assumption that the *general* atmospheric pressures in the formative stages of the earth were lower rather than higher than they are at present. What volume of atmosphere and what degree of atmospheric pressure may have been compatible with the gravitative power of the earth at such early stages as were first suitable for the evolution and preservation of organic compounds is not yet definitely postulated by the planetesimal hypothesis. It is merely assumed that a suitable atmosphere, hydrosphere, temperature and other conditions were found at some one of the progressive stages leading up to the present state and that there was a gradual transition from that stage to the existing state of things. So far as gravity alone is concerned, a sufficient atmosphere and hydrosphere might apparently be held when the earth had about one tenth its present mass, *i. e.*, about the present mass of Mars, which apparently holds an atmosphere and perhaps a hydrosphere.

If the earth were formed by a gathering of planetesimals into a nucleus which at an earlier stage was one of the nebulous knots of a spiral nebula, the value of the mass at the time it first became a solid body should have hung upon the ratio of the original knot to the scattered nebulous matter destined to be gathered into it, concerning which there is little to guide opinion. In this uncertainty, let it be assumed that at the stage when the growing earth was ready for the critical synthesis, its mass lay somewhere between one tenth and three fourths of the present mass, and that the mass of the early atmosphere held a proportionate ratio to the mass of the existing atmosphere. Let it also be assumed that at the time at which the hydrosphere began to gather about the globe, the earth's surface was formed of a heterogeneous, uneven, talus-like mantle, such as the infalling planetesimals would naturally produce, and that this constituted a deep porous zone. Until the hydrosphere was added there was a lack of efficient solutions and inwash to cement the fragmental material. The hydrosphere, in its first stages, must have occupied the lower part of this porous zone, and must have crept upwards as its volume increased. It should have appeared at the surface first in the bottoms of the deformation sags, the innumerable craters and the other depressions, and as it gradually extended itself, it must have linked more and more of the isolated water-bodies together. Throughout the earlier stages of growth, the prevailing aspect should have been that of innumerable small water-bodies scattered over the face of the land, rather than that of the great confluent ocean of to-day.

This then is the general physiographic setting which the planetesimal hypothesis, at least in one of its phases, presents for

the initiation of the chemical synthesis to which is assigned the task of bridging the gap between the inorganic and the organic compounds.

So far as chemical reactions of the familiar inorganic class are concerned, such a stage of earth-growth must obviously have presented conditions favorable to unusual activity, since the contact surfaces between the atmosphere and the hydrosphere, between the hydrosphere and the rock surfaces, and between the atmosphere and the rock surfaces, were all relatively large and varied, while the temperatures produced by the radiation received from the nebulous sun and by the heat of impact of the planetesimal matter may be presumed to have given a varied range of thermal conditions. As a result, reactions of exceptional variety should have been developed. In view of the vast number of bodies of water and their varied contacts with all sorts of rocks, together with the possibilities thus presented for the isolation of special combinations in their early stages and the correlative possibilities of conjunctions and minglings of these in their subsequent stages, there may well have resulted numerous diverse chains of sequences.

At that stage the atmosphere should have held each of its present constituents but probably not in the same proportions as now. The elements of lower specific gravity should have been smaller in amount relatively than at present, while those of higher specific gravity should have been more abundant relatively, because the controlling power of the smaller earth limited the range of molecular retention. Relative to the lighter constituents, it need only be added that, instead of escaping completely from the control of the earth, as postulated in the earlier phases of the doctrine of Stoney, the lighter molecules should in the main have escaped merely into the supplementary orbital atmosphere, where they might have persisted for long periods during which they were always subject to being driven back to the earth by occasional encounters, so that, although these constituents may have been rare in the denser collisional atmosphere near the earth's surface, they were doubtless present in sufficient amounts to have participated in any appropriate chemical synthesis. It is to be added further in qualification of this that, with the exception of hydrogen, which might have been derived from its compounds, the lighter atmospheric constituents, such as helium and neon, are chemically inert and there is no specific reason for supposing that they entered into any stage of the organic synthesis. The heavier constituents of the early atmosphere would include the compound gases of carbon, nitrogen, sulphur and phosphorus.

During the critical stages of growth, the infalling of planetesimals is supposed to have continued to be active. The planetesimals are assumed to have contained carbon, sulphur, phosphorus and all other elements found in organic matter; and as they impinged more or less violently upon the surface formed of previous accessions of similar matter, there should have been generated various compounds of these elements. A portion of these compounds should have been gaseous or vaporous and should have been variously disseminated into the atmosphere, or else absorbed into the waters or into the porous earthy mantle. The volcanic action of the period should have contributed its characteristic constituents in similar variety of combination. It may therefore be assumed with plausibility that a larger percentage and a greater variety of volatile compounds of the critical class prevailed in the air, subject to absorption into the earth-mantle

and the waters, during the stages of active terrestrial growth than at the present time, when terrestrial activities have more largely settled down into a state of less disturbed equilibrium. The same may doubtless be presumed of the unstable non-volatile compounds of the critical elements, but just here we are considering only the factor which worked through the atmosphere.

We have already denied ourselves any special appeal to *general* atmospheric pressure as an agency of the particular synthesis in question, but in doing this we have limited our abnegation to the sum total of pressure. It is still pertinent to inquire what may have been the effects of *partial* pressure. Starting with the familiar postulate that each constituent of a mixed gas acts in accordance with its own individual partial pressure, it appears that high partial pressures of the *critical* constituents should have been more effective in causing their entrance into combination than high general pressure without such high partial pressures. We have just seen that the chemical and physical conditions attending the stages of active earth-growth might well have given rise to large proportions of the critical compounds. By extending the argument it is not difficult to see that the actual amount of the carbon, sulphur, phosphorus and nitrogen gases might have been sufficiently greater than now to have promoted their union, for they all have high specific weights and could be held in relatively large proportions by the gravity of even a small earth. The gaseous compounds of nitrogen have a place in this class, though the free nitrogen was probably less abundant than now, but since free nitrogen is organically inert, it is negligible except as a source of its compounds.

If we turn to the non-volatile or slightly volatile compounds of the critical elements, we find, as already remarked, reason for thinking that there may have been more of the unstable compounds of this class than now, for secular progress would be in the direction of chemical stability. There are certain probable sources of unstable compounds of carbon, sulphur, phosphorus and nitrogen which call for special notice. Planetesimals are only one form of meteoroids and it is possible that the meteorites which reach the earth in appreciable masses may not often be true planetesimals of the class supposed to have formed the earth, but if the theory of common meteorites advanced by the senior author be the true one,[2] the compositions of the two classes are probably much alike, for according to this theory meteorites are supposed to be the fragments of small planetoidal bodies which have been disrupted by close approach to large bodies. These planetoidal bodies are supposed to have been too small to hold atmospheres and hydrospheres, and hence the planetesimals which formed them were never subjected to atmospheric and hydrospheric agencies, and hence they retained their planetesimal constitution with little modification.[3] This furnishes ground for assuming that the compounds found in meteorites were also present in the planetesimals. This presumption finds support in the nature of the case, for the gases shot forth from the sun to form the planetesimals probably were much dissociated by high temperature at the instant of emerg-

[2] *Astrophys. Jour.*, Vol. XIV., 1901, pp. 17–40; *Jour. Geol.*, Vol. IX., 1901, p. 369, and Chamberlin and Salisbury's "Geology," Vol. II., pp. 22–38.

[3] Dewar states that at a temperature of — 130° C. liquid oxygen has no chemical action on hydrogen, potassium, sodium, phosphorus, etc. (*Proc. Roy. Inst.*, Vol. 11, 1884–6, p. 550), and this is perhaps an additional reason why planetesimals and meteorites enveloped in the low temperatures of space prevalent at considerable distances from the sun have been subjected to little oxidation.

ence and later combined in all available ways as they met appropriate elements at the various lower temperatures through which they passed in the course of their cooling.

Meteorites contain a very suggestive series of compounds of the essential elements, carbon, oxygen, nitrogen, hydrogen, sulphur and phosphorus. Among these compounds it is especially interesting to note that several are unstable under the usual conditions that prevail at the surface of the earth. Among these are the phosphide, schreibersite, the sulphides, troilite, daubréelite and oldhamite, the carbide, cohenite and the chloride, lawrencite. These unstable compounds are sometimes intergrown or otherwise closely associated with one another, so that the products of any reactions that may grow out of their instability are favorably located for reaction upon one another, and such reaction is liable to arise when the celestial equilibrium is disturbed by terrestrial conditions. There is also present a form of graphite which oxidizes more rapidly than terrestrial graphite. Such graphite, as well as amorphous carbon, is intergrown with the unstable sulphide, troilite, and the unstable phosphide, schreibersite. The readily oxidizable graphite sometimes contains within itself sulphur and hydrocarbons. Roscoe extracted from a meteorite a hydrocarbon which contained sulphur.[4] Clöez and Pisani found in the Orgueil meteorite matter of the organic type which had a composition closely similar to terrestrial humus, viz., C, 63.45; H, 5.98; O, 30.57.[5] Lawrence Smith also extracted hydrocarbons from meteorites, among which was a compound of carbon, hydrogen and sulphur having approximately the composition of $C_4H_6S_4$; also one which he formulated as $C_4H_6S_5$.[6] Ansdell and Dewar favor the view that the hydrocarbons had their origin in carbides, a view supported by the observed presence of carbide in meteorites.

It may be assumed that the graphite resulted from the action of water, gases and other agents, on the carbides of the metals, and that during the chemical interactions which took place, a portion of the carbon became transformed into organic compounds.[7]

The hydrocarbons in meteorites embrace, according to Cohen, compounds of carbon and sulphur; of carbon, hydrogen and sulphur; and of carbon, hydrogen and oxygen, respectively. The hydrocarbons sometimes have a resinous or waxy aspect, and on decomposition may give an oil of bituminous or fatty odor. The compounds of carbon, hydrogen and oxygen afford extracts resembling peat, humus or lignite. All the alkalis, and all the earthy and metallic constituents which are essential to plant life are present in meteorites in variety and abundance. Besides the solid minerals, the gases carbon dioxide, carbon monoxide, methane, hydrogen, nitrogen and sulphuretted hydrogen are either present or are susceptible of development by moderate heat such as the infalls would inevitably produce.[8] It will be noted that these embrace the more common gases associated with ultimate organic reactions.

The chief point of interest here is not simply the presence, but the close intergrowth, of compounds of the organic elements in states of combination which, while stable in the cosmic regions surrounding the earth from which the planetesimal material was gathered, are pronouncedly

[4] *Proc. Phil. Soc. Mon.*, 1862.

[5] *Compt. rend.*, Vol. 59, 1864, pp. 37, 132.

[6] *Am. Jour. Sci.*, 1876, pp. 388–95, also 433–42. Many suggestive details.

[7] *Proc. Roy. Inst.*, Vol. XI., 1884–6, p. 549.

[8] For details see "The Gases in Rocks," R. T. Chamberlin, Carnegie publication No. 106, Washington, 1908.

unstable in the presence of the air and water, even at the ordinary temperatures at which organic synthesis takes place. On reaching the surface of the earth, these compounds would therefore have been no longer stable, but must have sought new relations. The transfer from the one state to the other may well have been accompanied by combinations not likely, or at least less likely, to arise under modern conditions of greater stability.

As already noted, a carbide of iron, nickel and cobalt is found in meteorites. The conditions attending the formation and infall of planetesimals encourage the belief that a wide range of carbides, and probably also of nitrides, may have existed among the accessions to the growing earth. But whether the amount of such material was large or small, it is clear that, as it was borne to the earth in the divided state of planetesimals, its measure of contact with the moisture of the surface was exceptionally large and hence the suggestive reactions which follow under these conditions should have been large in proportion to the amount of carbides and nitrides present. Even with cold water, the carbides of barium, strontium and calcium give rise to acetylene, while the carbides of aluminium and beryllium generate methane. Under the same conditions, uranium carbide gives rise to a gaseous mixture of methane, hydrogen and ethylene, and in addition to this generates considerable quantities of both liquid and solid hydrocarbons.[9] While nitrides are not known to furnish directly such a varied assortment of gases, they may readily give rise to ammonia gas under various conditions. Iron nitride, heated to 200° C. in the presence of hydrogen sulphide, yields iron sulphide, a sulphide of ammonium, and free hydrogen ($2Fe_2N + 6H_2S = 4FeS + 2NH_4HS + H_2$).[10]

It is impossible to follow the remoter reactions which might spring from these various first products of the carbides and nitrides by further interaction, but it is to be noted that all the new products, *if closely associated,* as the conditions of the case imply, were liable to meet one another while in the state of nascent activity, or in such stimulated activity as may attend previous activities, however this may be interpreted. Reaction might also have been aided by the catalytic relations into which these products came in their intimate association with the débris of the surface, with one another and with the new accessions added constantly to the earth's surface.

As already noted, the superficial portion of the growing earth is supposed to have been a loose, incoherent aggregate of highly fragmental planetesimal matter, and this was subject to weathering and various forms of comminution. The resulting porosity may have led to the condensation of much of the gaseous matter within its capillary and subcapillary pores, as soils are known to do at the present time. The graphite and amorphous carbon may have acted somewhat after the analogy of charcoal which is well known to absorb certain gases to a phenomenal extent. Various porous substances, including earths, possess this property of gas-condensation in appreciable degrees. Not a few metals also possess, irrespective of porosity, certain occlusive affinities or selective powers of absorption for certain gases, as palladium and platinum for hydrogen, etc. While the efficiency of charcoal is clearly due in large part to its extreme porosity, it is doubtless due in part also to the substance itself, for coal manifests a somewhat similar property. Fresh coal rapidly absorbs oxygen from the

[9] Moissan, *Proc. Roy. Soc.*, Vol. 60 (1897), pp. 156–60.

[10] Fowler, *Jour. Chem. Soc.*, Vol. 79, p. 297.

air, condensing it within the pores and crevices; but because of its activity in this condensed form, the oxygen soon unites with the substance of the coal and passes on to chemical union, making room for the absorption of more oxygen from the air.

Pursuing the phenomena of charcoal further by way of illustration, the well-known fact may be recalled that a layer of charcoal spread over decaying organic matter permits it to waste away gradually without giving off offensive odors, owing to the fact that the gases and the volatile products of the decomposition coming in contact with the charcoal are drawn into its pores and there oxidized by the condensed oxygen which the charcoal has absorbed from the air. Owing perhaps to a sort of catalytic action, the oxygen condensed in the pores of the charcoal becomes more active than the ordinary oxygen of the air. While charcoal furnishes the most declared case, soils and comminuted earth matter are known to possess similar properties in a notable degree.

In summation, we conclude that the porous mantle of the earth thus supplied by planetesimal infall with unstable carbides, nitrides, phosphides and sulphides undergoing transformation into more stable compounds, and generating during this process hydrocarbons, ammonia, hydrogen phosphide and hydrogen sulphide gases mingled with the ordinary gases carried by the planetesimals, furnished rather remarkable conditions for interactions and combinations, among which unusual syntheses would not be improbable.

If, with these special possibilities in mind, we turn to the question, what physiographic situation on the surface of the early earth presented the most favorable conditions for the organic synthesis, three general views offer themselves as alternatives, and under one of these there is a localization so specific as to have the force of a fourth view. The primitive organic synthesis may have taken place (1) in the ocean, (2) in some body of fresh water, or (3) on the land, or, more specifically, (4) in the soil. By soil in this connection is meant merely the earthy mantle of comminuted and weathered material; the absence of organic matter at the outset is of course assumed.

May we not take it for granted that the higher presumption will lie in favor of that localization which brings into closest interaction the requisite material in unstable states, attended by the maximum range of concentrations, condensations, catalytic, electrical, nascent and other favoring conditions?

If planetesimals carrying the essential constituents in unstable forms fell into large and deep bodies of water, the soluble and gaseous products of such reactions as followed would have been likely to be widely diffused and diluted, would have received little aid from the catalytic action of rock or earth material, would have been unassisted by soil porosity, and would have been but little favored by concentrations except such as involved an increase of density of all the constituents held in the water body whether favorable, hostile or indifferent in nature. Organic synthesis at present clearly involves a series of very special selections of material from among a miscellaneous association, the larger part of which is either neutrally obstructive or hostile. In the case of a completed organism, provided with the proper selective appliances, the requisite material may be gathered from such a dilute intermixture of the essential and non-essential materials as the water-bodies present, but until these selective appliances are provided, the water-bodies seem to us to be deficient in some of the most propitious conditions.

In the absence of such organic selective structures at the outset, it may be worth while to look for inorganic agencies that may perhaps have performed in a crude way the functions which the organic structures came later to perform in a much superior way. It is not clear that a selective concentrative agency can be found in the large water-bodies, independent of life, for their tendency is diffusive and equalizing rather than concentrative. Can it be found in the soil?

To form a definite picture of the conditions which may have been presented by certain soils, let a foreland lying between extensive uplands and a permanent water-body of appropriate salinity be chosen as a concrete example. In such a situation a constant water-level should have prevailed not only at moderate but at graded depths beneath the surface. The underground water should have received accessions percolating basinwards from the uplands bearing whatever soluble materials the uplands could furnish, while, on the other side, there should have been waters percolating landward from the water-body bearing such salinity as it possessed, while more or less spray from the water-body was scattered by landward winds over the surface and fed the soil from above. The measure of water-movement in the one direction or the other must obviously have depended on the balance between the precipitation and the evaporation on the adjacent land which varied with seasons and localities. The underground waters thus supplied by the slightly fluctuating water-table should have been carried up by the capillary passages of the soil to horizons of evaporation and concentration at or near the surface. The graded depth of soil above the water-table should have furnished unlimited adaptations to the porosity of the soil-mantle and to the meteorologic conditions of the seasons and the special situations.

The horizons of concentration by capillarity and by evaporation were affected by all degrees of insolation from direct sunlight, at the immediate surface, to all measures of shadowing below, furnished by the soil itself. The substances deposited within the soil and the substances leached from it, alike modified its porosity in their own special ways, and such deposits as were formed in the soils should have developed porosities of their own. Isolated cells and tubes may thus have been formed by travertine and similar deposits in the pores of the soil. As already implied, the capillary feeding from the water-table, when the balance set that way, and the partial evaporation of the solutions within the pores of the soil near or at the surface, must have produced concentrations of the non-volatile substances carried by the capillary waters into these upper horizons. Between these upper concentrated solutions and those below there should naturally have followed inter-diffusion and osmotic action, and thus there should have sprung up in the soil a circulation somewhat analogous to that of the plant; indeed, it may not be going too far to suggest that this circulation within the soil is more than a simple analogue of the systematic circulation which is definitely organized in the plant structure; it may possibly be its genetic forerunner. The larger cavities within the soil were inevitably connected by constricted passages which were liable to be partially or wholly filled with porous precipitates or with inorganic colloids, and these chains of pores might thus come to serve a circulatory function which was an actual precursor to that circulation from cell to cell through membranous walls which distinguishes compound plants. It is even more probable that the circulation within an earth-pore, partially isolated from adjacent earth-pores containing solutions of different density, might develop a circulation closely like that

of unicellular plants. A constant evaporation at the surface might perpetuate the differences of density sufficiently to continue the circulation for the requisite period. So, on the other hand, if the ground waters were sufficiently saline, the periodic accession of fresh water at the surface might give, in reverse order, density-differences sufficient to perpetuate circulation.

Whether analogy may be pushed so far as this on substantial grounds or not, it is obvious that the soil presents a suggestive assemblage of conditions favorable to chemical synthesis, and that these deserve a critical attention which the limits of this paper forbid us to try to pursue into fuller detail. It is clear that under these conditions evaporation was permitted to develop the greatest variety of concentrative effects which can well be assigned to it, and that at least some facilities were offered for the perpetuation and modification of these concentrations when once established. It is obvious that in the soil there might have been any degree of exposure of the reacting substances to light within very small differences of depth, and that there was easy intercommunication and commingling of the different products of such photosynthesis by means of capillary circulation. It is obvious that in the soils there might have been found the full range of capillary dimensions from coarse tubes and pores down to the limits of sub-capillarity with the full gamut of condensation-effects assignable to these. The same may be said of all catalytic effects referable to the relations of the solids and solutions concentrated in the soils.

An important class of chemical reactions observed in the matured plant of to-day takes place within the organism without much obvious addition or loss of material, apparently an internal readjustment of matter under its own stimulus. This is familiarly seen in the maturing of seeds after they have been separated from all connection with the plant circulation, in which little external change beyond some possible loss of moisture is observable. In many cases, germination will not take place at once; a period of internal organization or ripening must intervene. This thus represents a last stage of preparation for self-propagation, or, in other words, the last stage of an advanced phase of organic synthesis. It may not accord with conventional usage to call this self-catalytic action, but in some way it seems to be due to stimulus which the partially organized materials exert on one another and by which they thereby push farther forward the synthetic process. The prevalence of this internal action in the last stage of the organic cycle suggests that analogous action may occur far back in the synthetic series, and that much of the more complex part of the cycle may perhaps be accomplished by such action, conditioned like it on the confinement of the partially organized material in a cell-like cavity where it was subject to accessions of the sustaining solutions and to concentrations by the removal of water and volatile matter. If this speculative conception be warranted at all, the quasi-cellular structure of the porous soil might not inappropriately be conceived as serving the function of a rude inorganic husk, or shell, abetting by confinement and protection the internal synthesis of its contents.

If we may appeal to still other agencies whose functions are as yet imperfectly understood, the electrolytic action of earth-currents may be worthy of mention. It is well known that saline waters are better conductors of electricity than fresh waters or dry earth, and hence it is probable that the restoration of electrical equilibrium on the earth's surface after it has suffered dis-

turbance may be attended by electrical passages between the saline water-bodies and the land tracts. There are reasons for believing that electrical interchanges were more active in the growing stages of the earth than at the present time when the solar system may be presumed to have settled down into a condition nearer equilibrium. The planetesimal matter circulating about the planetary nucleus and the sun, and between them, probably served both to disturb the electrical status of these bodies and to afford a means of electrical communication between them and the planetesimals. Under electric laws, planetesimals charged with electricity and circulating at high velocities about the young planet should have had the effect of electrical currents, and should have generated magnetic fields about the magnetizable matter of the earth; and these magnetic fields, in turn, should have modified and perhaps controlled the paths of electrons and ions traversing these fields. It is beyond the scope of this paper to try to follow these into detail, and it may suffice to merely indicate that electrolytic action stimulated by electrical currents traversing the surface may fairly be presumed to have played a more active part during the nebular stages than they do to-day, whatever that part may be.

On similar grounds, it may be suggested that the agitations of radioactivity, and the states of ionization to which it gives rise, may have played a slightly more active part in the chemical processes of early times than they do to-day, whatever that may be, because of secular decay.

Some suggestions respecting the original localization of terrestrial life may be derived from a study of the localizations of to-day. The more primordial types of the vegetal life of the mid-ocean are limited in variety and in susceptibility to variation. In the judgment of some of our most trusted botanists, pelagic vegetal life does not present pronouncedly the qualities which imply germinal or evolutionary power. A similar statement may be made, with qualifications, relative to the life of the larger fresh-water bodies. In the shore tracts, indeed, there is greater variety of life and greater indication of germinal competency, but even here the forms which lie nearest the hypothetical primitive types do not give signs of conspicuous evolutional potency. On the other hand, the plant life of the land presents much greater variety of form and of organization, and greater signs of germinal virility.

If we may judge of the fitness of soils to serve as a nidus of organic genesis, by the life it fosters to-day, a favorable verdict seems warranted by the remarkable assemblage of low forms which make the soil their habitat and which manifest peculiar adaptations to their earthy conditions and to one another. There are not only a host of simple forms in which photosynthesis plays its usual part, but forms that flourish quite irrespective of sunlight; there are not only species that use carbon dioxide and require oxygen, but species that live quite without free oxygen, and even find it a hostile element; there are forms that oxidize sulphuretted hydrogen and use the energy thus derived for their activities, and there are forms that oxidize ferrous to ferric iron to like ends.[11] Some of the sulphur-bacteria seem to combine the generation of energy from sulphuretted hydrogen with the more common mode of oxidizing carbon compounds, thus uniting in a suggestive way independent chemical processes. There are also bacteria that oxidize free nitrogen into nitrites and others that promote the formation of nitrates. The rich

[11] Jost's "Plant Physiolcgy," Gibson's translation, 1907, pp. 220–31.

realm of soil life seems yet far from being exhausted by research either in respect to the range of forms or the scope of their chemical activities, but it is at least clear that the soil is the foster-ground of remarkable biochemical activities. Some large part of such activities is dependent on preexistent organic matter and is in no sense initial, but in a significant part of it, organic compounds do not seem to be prerequisite. This variety of action and these peculiarities of the life of the soil-mantle are at least suggestive of genetic conditions.

If we seek for such uncertain light as the geological record may throw upon the habitat of the first life, we are confronted by the fact that the record makes only a very distant approach to the real genesis of life. If we permit ourselves to reason from the nature of the Proterozoic formations, we find grounds for a belief in a very early mantling of the land surface with vegetation.[12] A study of the early habitat of some of the leading forms of life seems also to favor the land or the land-waters.[13] While these geological considerations have their obvious limitations and may seem to be too far removed from the specific question of organic synthesis to have much value, they may at least be permitted to serve as an offset to the prepossessions which seem heretofore to have obtained widely in favor of the origin of life in the ocean. They may also help to bring into equitable competition the view that primitive organic synthesis may have found its genetic conditions in some of the lowland soils on the borders of the permanent waterbodies.

[12] Chamberlin and Salisbury, "Geology," Vol. II., pp. 139, 199, 302.

[13] Chamberlin, "The Habitat of the Early Vertebrates," *Jour. Geol.*, Vol. VIII., 1900; Sardeson, "The Phylogenic State of the Cambrian Gasteropods," *Jour. Geol.*, Vol. XI., 1903; Chamberlin and Salisbury, "Geology," Vol. II., p. 480.

The original organic process was undoubtedly vegetative rather than animal in type, *i. e.*, the primitive organisms increased the sum total of organic matter and stored energy in it. The store of energy attained by any given plant consists (1) of that which it inherits with its spore, seed or germinal part and (2) of that which it adds thereto from terrestrial and cosmic sources of energy. If the plant feeds wholly on carbon dioxide, water, nitrates, sulphates, phosphates and similar *wholly oxidized* compounds, its sources of free energy are essentially limited to two classes: (1) radiant energy, derived chiefly from the sun and allied sources, and (2) chemical energy, derived from the oxidation of a portion of the germinal matter. The peculiar cooperation of these two sources of energy forms a distinctive combination. A part of the energy set free by germinal oxidation cooperates with the remainder and with solar energy to build up additional complex compounds. This new complex matter is built up from fully oxidized material by deoxidation combined with a synthetic process which gives it higher complexity. This process obviously requires additional energy. The synthetic function resides primarily in the germinal matter, for the formation of new compounds may proceed to certain lengths without sunlight; but the main source of the energy required for deoxidation resides in the sun. The germinal matter thus seems to have two phases of action: (1) simple oxidation, which gives free energy for its own activities, and (2) synthetic stimulus, by which complex carbon compounds are organized. This last takes place at the outset by the transformation of its own substance, but later, with the cooperation of sunlight, by the synthesis of simpler substances previously in a fully oxidized state.

Now, if any inorganic matter is to take

the place of this germinal matter in synthesis, it must apparently subserve this double function of suffering oxidation of a part to yield the energy required to organize its remaining part into other complex compounds. This peculiar double function seems to furnish a criterion which must probably be met, if we are to find in early terrestrial history any inorganic agency which may have subserved crudely the synthetic function which has since been developed so extraordinarily by self-perpetuating organic agencies. Are there any agencies among those previously under review which act in any such way, and which might be supposed, even by the license of hypothesis, to serve as a crude substitute or forerunner for the germinal matter?

Before trying to answer this crucial question, let another characteristic of organic matter as a source of energy be noted. The energy which can be derived from living matter by oxidation is distributed among many atoms, or, if it be interpreted as concentrated in certain of the atoms among the complex assemblage, it is so diluted or distributed by the neutral atoms present that its effect is distributive. *The end secured by this is a slow—perhaps one may say a controlled—use of energy in oxidation distributed over a prolonged period.* The organism is indeed a thermal engine, but its temperature is phenomenally conservative, uniform and sustained, and its consumption of fuel in any unit of time is small. At the same time its constructive work, both of material and of energy, is so much more conspicuous than its consumptive work as to almost completely mask the latter. This distributive conservative action is perhaps the key to the successful absorption and utilization of the mild but pervasive energies of cosmic origin which furnish the increment of energy necessary to increase the sum total, notwithstanding the portion expended.

Now if we gather together the essentials of the energy processes previously cited as probably present in the primitive days of the earth, shall we find in them any analogues of this cooperative, controlled and constructive process?

Summarizing these essentials in terms of energy, it appears (1) that several of the elements that take part in organic activities were probably present at the outset in a free state and capable of yielding their maximum of energy by oxidation, such as graphite, amorphous carbon, and perhaps sulphur, together with the free gases, hydrogen, nitrogen and oxygen; (2) that there were probably present simple binary compounds such as the carbides and nitrides, which were capable of reacting with water and of setting energy free, and at the same time generating somewhat more complex compounds; (3) that there were hydrogen compounds susceptible of oxidation with liberation of energy, such as the hydrocarbons, ammonia, sulphuretted and phosphoretted hydrogen; (4) that there were partially oxidized compounds susceptible of further oxidation with a liberation of energy, such as the nitrites and ferrous salts; (5) that there were fully oxidized compounds, end products, such as carbon dioxide and water, from which, *by the expenditure of energy,* the carbohydrates might hypothetically be derived by deoxidation and combination; as well as such end products as nitric acid, nitrates, sulphates and phosphates from which, in combination with the preceding, proteids and the nitrogenous group generally might, hypothetically, be compounded; (6) that there were abundant supplies of potassium, calcium, magnesium and silicon in combination from which these elements could be derived by similar means; (7) that there was

abundant diffuse energy in sunlight and other forms of solar radiance, and (8) there were pervasive free energies in states of ionization, in earth currents and in local electric potentials. In short, it appears that there was a group of oxidizable substances which might give up energy by combination, but not in indefinite amounts; that there was an ample supply of substances already oxidized to the full, but which could be partially deoxidized and combined hypothetically to give the complex organic compounds, but only at the expense of energy. A continuous source of pervasive, diffuse energy was afforded by sunlight and other forms of solar radiance, perhaps aided by molecular agitation through ionized states, diffuse electric earth-currents, and local electric potentials; and these sources were ample to meet the requirements of the case.

Recalling the combination of functions required, the most plausible suggestion is offered by the cooperation of the unstable carbides, nitrides, sulphides and phosphides with moisture, sunlight and allied agencies.

Somewhat after the analogy of germinal matter, certain metallic carbides react at ordinary terrestrial temperatures on the accession of water, freeing energy and raising the temperature, but retaining a portion of their power of oxidation and at the same time forming carbon compounds of slightly more complex nature. The phenomena of polymerization may intervene in some cases and favor complex compounds. Some of these compounds are unsaturated, and by additions and substitutions may lead on to other complexities.[14] If the reactions of these carbides took place in the presence of the associated unstable nitrides, sulphides, phosphides and chlorides, there is reason to believe that more complex results would follow, involving other organic elements. Experimental results do not greatly help on this point, because high temperatures, strong reagents and artificial conditions have usually been employed in forming the more complex compounds of the organic elements. Violent agencies and extreme conditions are excluded from organic action, and hence presumably from any antecedent action closely precedent to it. In the case in hand, combination could be abetted by evaporation, by porous condensation, by selective concentration, by catalytic action, by confinement in pores, cells and ducts, by capillary and osmotic action, by genial temperatures, by sunlight and by allied agencies. How far these could go in giving rise to the higher compounds of the organic type experimentation has not yet satisfactorily determined. The analogy of the carbide action does not go very far, but it is something that it takes even a short step in the direction so characteristic of organic synthesis.

While the foregoing combinations and activities seem to us suggestive of the most favorable primitive conditions, they obviously do not warrant anything approaching an affirmation that organic synthesis really took place in this way in the soil, or that it is the offspring of inorganic antecedents solely. It has been our endeavor to trace the early terrestrial conditions and activities into as close an analogy to those that dominate the organic kingdom as present imperfect data permit. The conservative considerations that make it unsafe to assign organic genesis to an early terrestrial age without reserve, simply because it is not now in evidence, find their complement in withholding opinion respecting the possibility of such genesis by any combination of inorganic influences whatsoever, until it shall be experimentally settled. The great problem

[14] Moissan, "The Electric Furnace," translation by Moulpied, pp. 244 and 256.

must lie open yet awhile at least, but every line of approach, however hypothetical, may well be pursued if controlled by due reservations.

As remarked at the outset, many of these considerations are applicable to states of the earth which might have arisen at an early day under any of the cosmogonic hypotheses. We have given precedence to one of these hypotheses partly because it seems to merit a fuller exposition in this particular than it has received, and partly because it seems to us to present a physiographic setting more favorable for synthesis than would probably have arisen under the alternative cosmogonic hypotheses.

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UNIVERSITY REGISTRATION STATISTICS—I.

THE registration returns for November 1, 1908, of twenty-five of the leading universities of the country will be found tabulater on page 912. One institution has been added to the list this year, namely, Western Reserve University. A special effort was again made this year to prevail upon the reporting officers to do away altogether with the first item of double registration, but without complete success, and it must, therefore, be borne in mind that an institution with a large double registration in the fall enrollment naturally makes a comparatively better showing in the schools in which this duplication occurs, than one where this item has been reduced to zero. Furthermore, some difference of opinion evidently still exists concerning the proper classification of students enrolled in extension courses, evening courses, etc., for entrance upon which standards of admission are, to all intents and purposes, nonexistent, and similarly there will be found in the summer session and even in regular faculties, for example, in music and agriculture, students who have not completed a high-school course. Then again, a few institutions demand a baccalaureate degree or its equivalent for admission to one or more of their professional schools, as Harvard does for law, medicine, theology and engineering, Johns Hopkins for medicine, and Columbia for law, whereas at certain other institutions admission to the professional schools rests practically on a high-school graduation basis. Another factor that must not be overlooked is the difference in the number of partial students in attendance on various institutions: Columbia and Chicago, for instance, are apt to have more than Princeton or Stanford, and this circumstance should not be lost sight of in preparing figures intended to show the proportion of officers to students. All of these points are mentioned in order to emphasize once more the fact that the figures herewith presented have, from the very nature of the case, little qualitative significance, inasmuch as such items as standards of admission and advancement, efficiency of instruction, equipment, and the like, are necessarily ignored in the comparison. The figures have in every instance been furnished by the proper reporting officer, who has, in a number of cases, added interesting information about the development of the institution involved during the year just past.

Comparing the figures for 1908 with those of the previous year, it will be seen that, in spite of the prevailing economic depression, only two institutions, Harvard and Stanford, show a slight loss in enrollment, whereas two years ago five suffered a decrease. Taking the total attendance into consideration, *i. e.*, including the summer session, the greatest gains in terms of student units have been made by Chicago, Columbia, Wisconsin, Indiana, Pennsylvania,

Cornell, California and Minnesota, each one of these having gained over four hundred students; omitting the summer session attendance, the largest increases have been registered by Columbia, Minnesota, Cornell, Northwestern, Wisconsin, Pennsylvania and Ohio, in the order given, the growth in each case being one of more than three hundred students. Comparing this year's grand totals with those of 1902, we find that Harvard and Princeton are the only institutions that exhibit a loss in registration during the intervening period, but the higher education of this country would suffer no deterioration if more of our institutions would only copy Harvard's standards at the risk of quantitative losses in enrollment. The largest gains during this period have been made by Pennsylvania, New York University, Illinois, Michigan, Cornell, Columbia, Syracuse, Minnesota, Missouri, Ohio and Iowa, each of these universities showing an increase of over one thousand students, an increase in which the establishment of summer sessions plays no small rôle in several instances.

According to the figures for 1907, the twenty-four universities included in the table ranked as follows: Harvard, Columbia, Michigan, Chicago, Cornell, Minnesota, Illinois, Pennsylvania, New York University, Yale, Wisconsin, California, Syracuse, Nebraska, Northwestern, Ohio, Missouri, Iowa, Kansas, Indiana, Stanford, Princeton, Virginia, Johns Hopkins.

Faculties	California	Chicago	Columbia	Cornell	Harvard (incl. Radcliffe)	Illinois	Indiana	Iowa	Johns Hopkins	Kansas	Michigan	Minnesota	Missouri	Nebraska	New York	Northwestern	Ohio State	Pennsylvania	Princeton	Stanford	Syracuse	Virginia	Western Reserve	Wisconsin	Yale
College Arts, Men	526	749	645	873	2231	402	536	518	166	427	1027	557	478	289	298	480	335	352	641	434	1387	292	310	842	1273
College Arts, Women	879	685	467		394	442	405	520	.....	515	653	909	432	523	167	495	323	20	.....	496		.....	269	788	.....
Scientific Schools*	818	.....	677	1727	109	1081	.....	223	.....	433	1352	684	677	630	232	.....	925	815	582	388	390	98	.....	894	967
Law	95	209	318	223	681	174	126	209	.....	184	706	523	260	168	809	252	125	326	.....	119	180	282	142	154	428
Medicine	36	148	306	207	319	502	260	302	355	79	445	244	55	110	408	524	.....	563	.....	.....	152	89	98	30	142
Graduate Schools	324	408	737	246	460	233	40	126	177	48	160	97	137	94	255	.....	71	339	91	95	45	31	15	216	391
Agriculture	137	.....	.....	394	.....	443	.....	.....	.....	.....	.....	1029	222	375	.....	.....	216	.....	.....	.....	.....	.....	.....	211	.....
Architecture	†	.....	131	130	†	182	.....	.....	.....	.....	†	.....	.....	.....	.....	.....	†	168	.....	.....	60	.....	.....	.....	.....
Art	107	.....	.....	.....	.....	4	.....	†	.....	22	.....	†	.....	52	.....	.....	.....	.....	.....	.....	80	.....	.....	.....	45
Commerce	183	.....	.....	.....	56	136	.....	†	.....	.....	†	.....	.....	.....	875	213	.....	463	.....	.....	.....	.....	.....	†	.....
Dentistry	56	.....	.....	.....	66	105	.....	163	.....	.....	192	192	.....	.....	.....	247	.....	383	.....	.....	.....	.....	63	.....	.....
Divinity	.....	198	.....	.....	30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	235	.....	.....	.....	.....	.....	.....	.....	.....	106
Forestry	†	.....	.....	.....	†	.....	.....	†	.....	.....	†	†	.....	36	.....	.....	35	.....	.....	.....	.....	.....	.....	.....	70
Music	†	.....	25	.....	.....	81	.....	61	.....	126	.....	†	.....	450	.....	255	.....	35	.....	.....	690	.....	.....	216	91
Pedagogy	†	183	950	.....	.....	.....	.....	†	.....	.....	†	31	315	262	469	.....	30	†	.....	.....	102	.....	.....	†	.....
Pharmacy	65	.....	284	.....	.....	229	.....	65	.....	94	102	89	.....	12	.....	171	77	†	.....	.....	.....	.....	75	87	.....
Veterinary	†	.....	.....	91	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14	.....	186	150	.....	.....	.....	.....	.....	.....	.....
Other Courses	.....	292	.....	358	.....	38	.....	50	.....	.....	.....	.....	60	.....	.....	270	119	624	.....	.....	40	.....	58	.....	.....
Deduct Double Registration	*27*	*209*	.....	*3*	*10*	.....	.....	*115*	.....	*62*	.....	.....	*416*	*80*	*70*	*150*	.....	*15*	.....	.....	*42*	*35*	*14*	*151*	*65*
Total	3199	2663	4540	4246	4336	4052	1367	2122	698	1866	4637	4355	2220	2921	3457	2992	2442	4223	1314	1532	3084	757	1016	3237	3448
Summer Session, 1908	661	2991	1532	841	1349	656	1005	363	.....	381	1086	332	508	348	626	257	503	472	.....	60	189	.....	.....	1027	48
Deduct Double Registration	*109*	*540*	*397*	*387*	*345*	*308*	*259*	*129*	.....	*161*	*535*	*80*	*170*	*115*	*132*	*136*	*245*	*140*	.....	*51*	*69*	.....	.....	*388*	*30*
Grand Total, 1908	3751	5114	5675	4700	5342	4400	2113	2356	698	2086	5188	4607	2558	3154	3951	3113	2700	4555	1314	1541	3204	757	1016	3876	3466
" " 1907	3346	4594	5197	4293	5346	4172	1667	2188	651	1932	4953	4207	2274	2812	3648	2714	2344	4134	1311	1594	3162	757	914	3401	3435
" " 1906	3246	4731	4650	4075	5343	3810	1515	1950	618	1690	4674	3944	2071	2807	3283	2635	2180	3934	1352	1530	3004	745	905	3099	3477
" " 1905	3631	4557	4755	3871	5283	3635	1377	1700	688	1706	4521	3940	1887	2635	2912	2791	2057	3430	1361	1606	2776	696	856	3083	3477
" " 1904	3738	4035	4833	3833	5392	3369	1206	1460	740	1446	4000	3886	1704	2728	2380	2856	1758	3027	1385	1424	2452	691	808	3370	3008
" " 1903	3690	4146	4557	3438	6013	3239	1614	1260	694	1319	3926	3550	1540	2513	2177	2740	1710	2644	1434	1370	2207	638	765	3221	2990
" " 1902	3676	4296	4302	3281	5468	2819	1648	1320	669	1294	3764	3505	1408	2560	2201	2875	1603	2549	1345	1378	2020	586	.....	2884	2804
Extension and Similar Courses	1150	2	2879	.....	1132	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	.....	.....	.....	.....	.....	80	1165	.....
Officers	303	303	655	572	654	477	100	160	192	126	409	200	195	240	338	368	209	466	168	139	220	94	227	395	397

* Includes schools of mines, engineering, chemistry and related departments.

† Included elsewhere.

‡ The attendance on the 188 courses given during the past year was 53,841.

Comparing this with the order for 1908, we observe that Columbia now heads the list, having changed places with Harvard, Pennsylvania has passed Illinois, Wisconsin and California have passed Yale, and Indiana has passed Kansas. Omitting the summer session enrollment, the order is, of course, somewhat different, namely, Michigan, Columbia, Minnesota, Harvard, Cornell, Pennsylvania, Illinois, New York University, Yale, Wisconsin, California, Syracuse, Northwestern, Nebraska, Chicago, Ohio, Missouri, Iowa, Kansas, Stanford, Indiana, Princeton, Western Reserve, Virginia, Johns Hopkins—Columbia and Minnesota having passed Harvard, Cornell having passed Pennsylvania, New York University having passed Yale, California having changed places with Syracuse, Northwestern with Nebraska, and Missouri with Iowa.

Considering in order the various faculties, we find first, that so far as the undergraduate academic department is concerned, there has been a general increase of men as well as of women, the actual and percentage gains being larger in the case of the male than in that of the female students. Chicago, Harvard, Princeton, Stanford, Virginia and Yale have experienced losses in the number of male academic students, while California, Michigan, Minnesota, Nebraska and Northwestern—all western institutions—have fewer academic women students than they had last year. At more than half of the western institutions there are more women than men in the academic department, the exceptions being Chicago, Indiana, Michigan, Missouri, Ohio, Western Reserve and Wisconsin. In all of the eastern institutions, on the other hand, with the possible exception of Cornell and Syracuse, who do not separate their academic registration into two divisions, the number of men is considerably in excess of that of women. In spite of a large growth this year in the number of men, Wisconsin still has fewer than it had in 1904, while the number of women is larger by 180. Comparing the total academic enrollment—men and women—for 1908 with that for 1902 in the case of those institutions which are included in the tables of both years, we find that there has been a loss in numbers at Chicago, Indiana, Nebraska, Pennsylvania and Princeton, while the largest gains in the academic division during the same period have been made by Syracuse, Wisconsin, Michigan, Missouri, Northwestern, Minnesota and Columbia. The scientific students were grouped with the academic students at California and Stanford in 1902, and consequently no comparisons can be made for these institutions. The largest number of male academic students is still found at Harvard, which is followed by Yale, Michigan, Wisconsin, Chicago, Columbia, Princeton, Minnesota, whereas if the women be included the order would be Harvard, Michigan, Wisconsin, Minnesota, Chicago, California, Syracuse, Yale, Columbia, Iowa—each of these enrolling over one thousand academic students.

The only institutions that have registered a decrease in the number of scientific students are Harvard, Kansas, Nebraska and Virginia, and of these the first mentioned is the only one that shows a loss as compared with 1902, of course owing to the fact that the baccalaureate degree is now required for admission to the Harvard engineering schools. The gain in this field since 1902 is in several instances quite remarkable, *e. g.*, from 597 to 1,352 at Michigan. The largest number of scientific students is still found at Cornell; Michigan and Illinois being the only others that attract over one thousand students to their scientific schools; these are followed by Yale, Ohio State, Wisconsin, California,

Pennsylvania, Minnesota, Columbia, Missouri, Nebraska and Princeton, each of these universities having over five hundred students in attendance on their scientific schools.

The attendance on the schools of law connected with the universities under consideration shows, in general, a fair gain since last year, whereas in the case of the medical schools the gain is only slight; in fact, there are at present no less than approximately eight hundred fewer students of medicine in attendance on the institutions credited with medical schools in the tables of both 1908 and 1902, than there were in the latter year, while in the case of the law schools there has been a gain of about five hundred students during the same period. Minnesota, Yale, Columbia and Virginia exhibit the largest increase in law since last year, Indiana,[1] Minnesota and Illinois in medicine; Harvard, Illinois, Indiana,[1] Michigan, New York University and Ohio showing losses in law, and California, Cornell, Harvard, Kansas, Missouri, Nebraska, New York University, Northwestern, Pennsylvania and Virginia in medicine. New York University still possesses the highest law school enrollment, being followed by Michigan, Harvard, Minnesota, Yale, Pennsylvania, Columbia and Virginia. Of these the Harvard and Columbia schools are the only ones on a graduate basis. Pennsylvania continues to have the largest medical school, followed by Northwestern, Illinois, Michigan, New York University, Johns Hopkins, Harvard, Columbia and Iowa—Harvard and Johns Hopkins having the only graduate schools of medicine among those here mentioned.

The graduate schools show healthy gains all along the line, with the exception of Indiana, Syracuse, Princeton and Nebraska, the increase being especially noteworthy at Michigan, California and Illinois—all western institutions. Columbia, with an enrollment of 958 students (to the 737 in the table should be added 221 graduate students at Teachers College, who are omitted here for the sake of avoiding the item of double registration), has by far the largest graduate school, followed by Harvard, Chicago, Yale, Pennsylvania, California and New York University.

The agricultural schools show a most encouraging increase, practically without exception, Minnesota this year having an enrollment of over one thousand, being followed by Illinois and Cornell. The schools of architecture have likewise grown, the largest being those connected with Illinois, Pennsylvania, Columbia and Cornell. The largest schools of commerce are at New York University and Pennsylvania, and they exhibit a large increase over last year. The dental schools for the most part have suffered a loss, Pennsylvania still having by far the largest number of dental students, being followed by Northwestern. The latter, Chicago and Yale show a slight gain in the number of divinity students, whereas the enrollment at Harvard has remained stationary. Where the forestry students are listed separately, a small increase is apparent, whereas a number of institutions have registered losses in music, Syracuse, with 690 students, still heading the list in the latter department, followed by Nebraska and Northwestern. Syracuse is the only institution to report a decrease in the number of students of education, Teachers College of Columbia University, with 950 students, continuing to head the list, being followed by New York

[1] The large increase in the school of medicine is accounted for by the consolidation of all the medical schools in Indianapolis and their absorption by Indiana University, while the falling off in the school of law is due to the fact that all the duplicates have been eliminated this year, only actual candidates for the law degree being included.

University and Missouri. All of the schools of pharmacy, with the exception of that of Illinois, have experienced satisfactory gains in attendance, Columbia now having the largest enrollment, with Illinois second and Northwestern third. Ohio State and Pennsylvania report gains in veterinary medicine, these being the two largest schools.

Northwestern, Stanford and Syracuse are the only institutions that experienced a loss of students in the summer session of 1908, the Yale summer courses having been withdrawn this year. In some instances, the growth has been quite noteworthy, for example at Wisconsin, where no less than 1,027 students were enrolled, as against 651 in 1907, and at Indiana, which reported an increase from 721 to 1,005. In addition to Chicago, the following institutions attracted over one thousand students last summer, ranking numerically in the order given: Columbia, Harvard, Michigan, Wisconsin and Indiana. The students taking summer work in surveying, geodesy or mining are not included in the Columbia figures.

The eastern colleges for men and those for women included in the writer's geographical distribution statistics[2] all report gains in the fall registration over last year, with the single exception of Bryn Mawr. The Massachusetts Institute of Technology shows an increase from 1,415 to 1,462, Purdue one from 1,518 to 1,534. Similarly Bowdoin has grown from 394 to 419, the loss in medicine occasioned by an increase in standards being more than offset by gains in the collegiate department, Amherst from 513 to 525, Dartmouth from 1,219 to 1,233 (the academic department from 1,131 to 1,136), Brown from 924 to 995 (the academic department from 661 to 727), Wesleyan from 316 to 319, Lehigh from 655 to 664, Wellesley from 1,209 to 1,281, Smith from 1,482 to 1,561, Mt. Holyoke from 711 to 746, and Vassar from 996 to 1,014, while Bryn Mawr has registered a decrease from 407 to 395. Comparing the enrollment of these institutions with that for November 1, 1903, we note a slight loss in attendance at Wesleyan (3 per cent.), Massachusetts Institute of Technology (4 per cent.), and Bryn Mawr (7 per cent.), while gains have been made in the following order: Smith, 51 per cent.; Dartmouth, 42 per cent.; Wellesley, 31 per cent.; Purdue, 29 per cent.; Amherst, 28 per cent.; Bowdoin, 14 per cent.; Mt. Holyoke, 11 per cent.; Lehigh, 10 per cent.; Vassar, 9 per cent., and Brown, 6 per cent. In the case of the Massachusetts Institute of Technology, the relatively large registration in 1903 (1,528) was due to the unusually heavy enrollment in the class of 1906, which entered immediately before the increase in entrance requirements and in tuition fees became operative. During the past ten years the percentage of students entering the Massachusetts Institute of Technology from other colleges has grown from 6 to 13 per cent. At Bryn Mawr the decrease in numbers is accounted for by the facts that the fees for board were increased from $175 to $200 in 1907 and that the charge for tuition for undergraduate students was increased by $50 in 1903. It has been the policy of the board of directors to limit the attendance to the number which can be accommodated in the halls of residence, and for the last year or two the enrollment has been within forty of that number. The entering class at Dartmouth is smaller than it was last year, owing to the financial stringency of the past year. At Mount Holyoke the increase in registration is due to the larger number of rooms at the disposal of students, the number accepted each year being determined by the accommodations available on the campus and in the village. At

[2] SCIENCE, October 30, 1908.

present admission is being refused to several hundred applicants each year. At Vassar the total number of students is limited to about one thousand.

The following changes in the course of study and additions to the equipment have been reported: At Dartmouth a new dormitory, New Hampshire Hall, accommodating 107 students, has been erected, and the chapel has been enlarged, its capacity having been increased about half. Wesleyan has adopted a new course of study, which substitutes the "group and major" system for the semi-required system of previous years. English is the only subject required of all students, while candidates for the B.S. degree must take some mathematics and some modern languages. North College, the new dormitory to take the place of old North College, burned a few years ago, was opened last January and is now fully occupied. The most important change instituted at Lehigh this fall is the establishment of a conference department, which provides extra instruction in modern languages, mathematics, physics, and chemistry for freshmen and sophomores, the purpose being to furnish help at a very low rate to students of the first two years who experience difficulty in handling their work. Smith reports the erection of a new college library, which is to be ready for occupancy next September, and Mount Holyoke the addition of a music hall—containing a concert room, class rooms and practise rooms—and a library, which are to be completed before the close of the present academic year. The Sanders Laboratory of Chemistry, at Vassar, is to be completed before the second half-year. An additional instructor has been engaged for the German department, who gives her entire time to colloquial practise. A half-year of work in the history of philosophy is now prescribed as a prerequisite for the senior course in ethics, both of these courses being required at Vassar for the A.B. degree. At the Massachusetts Institute of Technology physical training has been prescribed for all first-year students.

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(To be concluded)

JAMES FLETCHER

Doctor James Fletcher, botanist and entomologist of the Experimental Farms System of Canada, died November 8 in Montreal. He had been suffering for some time with internal hemorrhage, and went to Montreal to consult a specialist. He remained there for a week under treatment, but in spite of expert medical assistance the illness terminated fatally. Doctor Fletcher was one of the most widely known and most universally loved entomologists in North America. He was also widely known among the botanists and other men of science. He had been connected with the American Association for the Advancement of Science since 1883, had attended most of the meetings, and had thus become known to very many.

He was born at Ashe, Kent, England, March 28, 1852. He was educated at Kings School, Rochester, England, and came to Canada in 1874, taking a position in the Bank of British North America. Later he became connected with the Library of Parliament at Ottawa, and in 1887 was made entomologist and botanist to the Dominion Experimental Farms, and entomologist to the Geological Survey. His acquaintance with Canadian naturalists was, of course, even wider and closer than with those of the United States. He organized the Ottawa Field Naturalists' Club and was president of it. He was one of the leading spirits in the Ontario Entomological Society, and for a long time had been a fellow of the Royal Society of Canada, at one time holding the office of honorary secretary and honorary treasurer of that important organization. He was the heart and soul of the Botanical Club of Canada. He was also a fellow of the Linnean Society of London,

and had received the honorary degree of LL.D. from Queens University. He was also a member of the St. George's Society and of the Rideau Club of Ottawa. Doctor Fletcher threw his whole force into his scientific work. He was a practical man, and was constantly looking for the practical applications of both zoological and botanical science. At the same time he was a close observer and made innumerable observations of novelty and value. As a public speaker he was unexcelled, and the educational value of his addresses to farmers and others on timely and practical topics was very great. During the time of his occupancy of his official position he published a valuable series of annual reports which, in their bulk, constitute a compendium of the economic botany and entomology of Canada for the whole period. He published also many shorter articles in the scientific journals of both Canada and the United States.

Aside from the practical aspect of his work Fletcher was of the type of the old naturalists. He loved nature deeply. Asked a short time ago by a friend why he did not take a holiday and a rest from his incessant labor, he replied: "Why should I take a holiday? My whole life is a holiday because I love my work." Everything living interested Fletcher. To take an excursion with him was a delight. His quick eye saw everything. His philosophic mind sought at once for the why and wherefore. He had no patience with the careless and unobservant. In the course of a typically fascinating and eloquent lecture that he delivered years ago before the National Geographic Society in Washington, on the Canadian Northwest, he was describing the journey from Winnipeg westward on the Canadian Pacific railway. He had dilated upon the flower-massed prairies and the other natural beauties with his hearty enthusiasm and then, he said: "Suddenly the glorious mountains came in sight. I could not contain myself. I must share my delight with some one. I touched the man in the seat ahead on the shoulder. 'See, see the mountains'! I said. 'Ah! indeed'! said the man! And then," said Fletcher with a fine show of indignation, "he went back to his *trumpery* novel!"

Among his many enthusiasms possibly his interest in the biology of the diurnal Lepidoptera was the greatest, and he was the first to work out the life history of *Œneis macounii* and other rare forms. His relations with that master of American butterfly lore, Samuel H. Scudder, were of the most intimate personal kind, and his death will be a sad blow to that other beautiful and strong character whose life is now fading away in Cambridge.

Probably no other Canadian naturalist was so well known and so well loved by his colleagues in the states as was Doctor Fletcher. Surely he will be as deeply mourned here as in his own country.

L. O. HOWARD

THE SMITHSONIAN INSTITUTION

THE annual meeting of the board of regents of the Smithsonian Institution was held at 10 o'clock on the morning of December 15 at the institution. The chancellor, Chief Justice Melville W. Fuller, presided, and the following regents were present: Vice-President Charles W. Fairbanks, Senator Shelby M. Cullom, Senator Henry Cabot Lodge, Senator Augustus O. Bacon, Representative James R. Mann, Representative William M. Howard, Dr. James B. Angell, Dr. Andrew D. White, the Honorable John B. Henderson, Dr. Alexander Graham Bell, the Honorable Charles F. Choate, Jr., and the secretary, Mr. Charles D. Walcott.

The appointment of the Honorable Charles F. Choate, Jr., of Massachusetts, as a citizen regent in place of the Honorable Richard Olney, resigned, was announced.

The secretary presented his report for the fiscal year ending June 30, 1908, which was accepted. Statements were received from the permanent and executive committees. The resignation of Dr. Cyrus Adler, assistant secretary of the institution, in charge of library and exchanges, was announced, and also the death of Professor Otis T. Mason, head curator of the department of anthropology of the National Museum.

A statement was presented of the affairs of the institution since the close of the fiscal

year. Referring to the institution's part in the International Congress on Tuberculosis, held in the new National Museum building, September and October last, it was stated that the institution, in conjunction with the Indian bureau, exhibited the results of an expedition by Dr. Ales Hrdlicka, of the U. S. National Museum, among the Menominee, Sioux, Quinault, Mohave and Hopa Indian tribes, for the purpose of showing the extent of tuberculosis among the Indians. The congress awarded the institution a gold medal for this exhibit. Of the appropriation of $40,000 made for the purpose, $25,000 was used and $15,000 went back to the U. S. Treasury.

The board was informed of the removal of the Greenough statue of Washington from its long-accustomed position east of the capitol to the Smithsonian Institution. The statue is now on the lawn south of the west wing of the building, whence it will be removed into the building as soon as the necessary foundation can be provided.

There was submitted a brief statement of the art objects in the collection of Mr. Charles L. Freer, of Detroit, the title to which has already passed to the institution. These comprise 2,873 objects in all branches of art. A number of valuable recent additions have been made which with the original donation represent a cost to the donor of nearly a million dollars.

The secretary read a letter from President Roosevelt, dated June 20, 1908, stating his intention of visiting Africa after the expiration of his term, and offering to give to the Smithsonian Institution for the National Museum the results of his expedition, provided the Smithsonian should send the necessary naturalists to prepare and ship the materials. The offer was accepted by the secretary, and arrangements were at once made by the secretary to provide funds for the expenses of the Smithsonian representatives, without using the Smithson fund or money derived from any government appropriation. Upon motion of the Vice-President, a resolution was adopted conveying the thanks of the board to the President for his very generous offer, and the acceptance of the offer. A further resolution was adopted thanking the donors of the funds for the expedition.

Progress on the new building for the National Museum was reported and it was thought that the building would be occupied in the summer of 1909. In keeping with the improvements projected for this locality, the board adopted a resolution expressing its sense that the further use of B Street, Northwest, just north of the new building between 9th and 12th Streets, for market purposes, be prohibited.

It was reported that Mr. C. G. Abbot, director of the Smithsonian Astrophysical Observatory, had established a station on Mt. Wilson, California, through courtesies extended by the Carnegie Institution of Washington, where measurements of the sun's radiation may be conducted as free as possible from earth tremors and cloud interference. A shelter will also be erected by the institution on Mt. Whitney, California, at an elevation of over 15,000 feet above sea level for the study of the atmosphere under the peculiarly favorable conditions there prevailing.

A resolution was adopted establishing a medal to be known as the Langley medal, as a tribute to the late Samuel Pierpont Langley, third secretary of the Smithsonian Institution, to be awarded for specially meritorious investigations in connection with the science of aerodromics and its application to aviation.

THE BALTIMORE MEETING

A PRELIMINARY announcement of the arrangements for the convocation week meeting of the American Association for the Advancement of Science and the affiliated societies, which begins at the Johns Hopkins University, Baltimore, on Monday, December 28, will be found in the issue of SCIENCE for November 27. In the present issue of SCIENCE will be found a list of the sections of the association and of some twenty-five national scientific societies which meet in affiliation with it. These and other issues of SCIENCE contain various notes concerning features of interest to men of science, which will form

part of the programs of the association and of the national societies. The meeting promises to be of unusual interest; there is reason to believe that the attendance and the value of the scientific programs will not be exceeded by any of the preceding convocation week meetings.

For the convenience of members of the special societies, it may be noted here that the American Association for the Advancement of Science expects to meet next year at Boston. There will be no summer meeting, but the British Association for the Advancement of Science has invited members of the American Association to take part in the meeting to be held in Winnipeg at the end of August. Plans have been proposed for a summer meeting in the Hawaiian Islands in the summer of 1911, with a possible meeting on the Pacific Coast, and it would be advisable for any societies or individuals who might like to take part in such a meeting to communicate with the permanent secretary of the American Association. After two meetings on the Atlantic seaboard, the association and the affiliated societies would expect to meet in the central states in convocation week of 1910–11. At the Chicago meeting a cordial invitation was presented to meet in Minneapolis on the earliest available occasion. The place of meeting will be recommended by the nominating committee at Baltimore, and invitations and suggestions should be communicated to the permanent secretary of the American Association or to the secretaries of the affiliated societies.

At a meeting of plant pathologists held at Washington, D. C., December 15, 1908, and after consultation with several experiment station pathologists, it was unanimously decided that an effort should be made to organize an American pathological society. A committee consisting of the following members, C. L. Shear, Donald Reddick and W. A. Orton, was appointed to arrange for a preliminary meeting in connection with the American Association for the Advancement of Science at Baltimore. Invitations have been issued to plant pathologists to meet December 30, 1908, at an hour and place to be announced later and take part in the organization of the proposed society which, it is believed, can exercise great influence in advancing the study of phytopathology in America.

The tenth annual meeting of the Society of American Bacteriologists will be held in the rooms of the pathological laboratory of the Johns Hopkins Medical School, Baltimore, on December 29, 30 and 31, in affiliation with the American Association for the Advancement of Science. The program will be arranged to permit of joint meetings with Sections K and I of the association and the American Health League on the above dates, where subjects of interest to the members of the society will be under discussion.

The Botanical Society of America will hold its fifteenth annual meeting, in conjunction with the American Association, at Baltimore, on December 28, 29 and 30, under the presidency of William F. Ganong. The scientific sessions will be held at the Eastern High School in alternation with those of Section G of the association. The address of the past-president, Professor G. F. Atkinson, will be given on Tuesday, December 28, at eight P.M., in McCoy Hall. After the address members and visiting botanists will be invited to remain to meet Professor Atkinson and the officers of the society. On Wednesday evening there will be a dinner for botanists at Hotel Caswell. The special features of the scientific program for the Baltimore meeting will be addresses by Professor Roland Thaxter and Professor J. C. Bose; symposia on "Progress in the Study of Vascular Anatomy of Higher Plants," on Tuesday morning, and on "Present Problems in Plant Ecology" on Wednesday afternoon; a Darwin memorial session on Thursday afternoon. The symposia are arranged in accordance with the desire generally expressed at the Chicago meeting, that more time be given in the programs of the Botanical Society of America to synthetic papers given by leading workers, upon invitation by the council. The Darwin memorial session will be devoted to a series of addresses giving estimates of Darwin's service to botany in the several fields in which he worked. It is in-

tended to supplement and not to encroach upon the Darwin memorial session of the American Association.

Section K—Physiology and Experimental Medicine—of the American Association will hold two sessions at Baltimore. At the first, on Tuesday afternoon, Dr. Ludwig Hektoen, of the University of Chicago, will give the vice-presidential address on "Opsonins and Other Anti-bodies." This will be followed by a symposium on the "Regulation of Physical Instruction in Schools and Colleges, from the Standpoint of Hygiene." Those who will take part are Dr. William H. Howell, Dr. R. Tait-Mackenzie, Dr. Thomas A. Storey, Dr. Frederic S. Lee and Dr. Theodore Hough. At the second session, which will be held on Wednesday afternoon, and is a joint meeting with the American Physiological Society, the Society of American Bacteriologists and the American Society of Biological Chemists, general papers will be presented by Dr. M. J. Rosenau, Dr. Lafayette B. Mendel and Dr. Albion W. Hewlitt.

Dues of Members of the American Association for the Advancement of Science.—The permanent secretary of the American Association for the Advancement of Science urges all members of the association to make an especial effort to pay their dues for the year 1909 before the first of January, and as far in advance of that date as is now possible. He calls the attention of members to the notice in Science, No. 728, December 11, 1908, page 834, to the effect that the publishers of Science will require members to pay the postage on back numbers at the rate of one cent per number provided they pay their dues after the beginning of the year. It is most important for the proper conduct of the business of the association that dues should be paid promptly.

SCIENTIFIC NOTES AND NEWS

The Vienna Academy of Sciences has elected M. Henri Poincaré, the eminent mathematician, to honorary membership. Among the corresponding members elected is Dr. G. H. Darwin, Plumian professor of astronomy at Cambridge.

Dr. Sergius Nawaschin, director of the Botanical Garden at Kiev, has been elected a corresponding member of the Munich Academy of Sciences.

M. Henneguy has been elected a member of the Paris Academy of Sciences in the Section of Anatomy and Zoology in the room of the late M. Giard.

The gold medal awarded under the Shaw Trust for Industrial Hygiene has been presented to Professor Galloway by the Royal Society of Arts, "In recognition of his valuable researches into the action of coal dust in colliery explosions, the outcome of which researches has been the provision of means by which the risk of such accident is materially diminished, and a consequent great saving of human life effected."

Students of the senior class of the Medical Department of the University of Buffalo, have presented Dr. Roswell Park with a silver service in honor of his completion of a quarter of a century as professor of surgery in the institution.

Professor William Kent, until recently dean and professor of mechanical engineering in the L. C. Smith College of Applied Sciences of Syracuse University, has accepted the position of general manager of the Sandusky Foundry and Machine Company, Sandusky, Ohio.

Dr. H. Morize has been appointed director of the Rio de Janeiro Observatory in the room of the late Professor L. Cruls.

Mr. Wilbur Wright, on December 18, again broke, at Le Mans, the aeroplane records for both duration and height of flight. In the morning he remained in the air one hour, fifty-three minutes and fifty-nine seconds, and in the afternoon attained an altitude of 360 feet.

The expedition to the Bismarck archipelago, which was organized a year ago by the Prussian ministry of education, has been unfortunate in losing its leader, Dr. Emil Stephan, who died in New Mecklenburg on May 25. The leadership of the expedition has been taken over by Dr. Krämer, whose former work in the western Pacific is well known.

IT is stated in *The Condor* that Mr. Austin Paul Smith has returned from Mexico and is now working with the birds on the United States side of the lower Rio Grande in the vicinity of Brownsville, Texas.

DR. VERNON L. KELLOGG, professor of entomology at Stanford University, is spending the present year abroad. He will be in Paris until May, and may be addressed care of the American Express Company, 11 rue Scribe, Paris.

PROFESSOR C. V. TOWER, of the University of Vermont, has gone abroad for graduate study and travel.

PROFESSOR EDWARD B. TITCHENER, of Cornell University, will give at the University of Illinois, a series of lectures in psychology, probably during the latter part of March.

DR. ALBRECHT PENCK, professor of geography in the University of Berlin, and Kaiser Wilhelm professor in Columbia University for 1909, has lectured before the Geographical Society of Philadelphia, on "The Origin of the Alps."

IT is planned to collect $7,500 with which to purchase the valuable chemical library of the late Professor W. O. Atwater, and present it to Wesleyan University. The library contains more than 5,000 volumes, including about 2,500 volumes of periodicals.

MR. JOSEPH H. PAINTER, assistant in the division of botany, National Museum, Washington, D. C., was drowned in the rapids of the Potomac on December 6, 1908, near the headquarters of the Washington Biologists' Field Club, of which he was a member. The evidence tends to show that he was overturned in a canoe with a boy companion, Robert S. Wallis, and lost his life in the vain endeavor to rescue his friend, who was unable to swim. The Field Club has added to the efforts and incentives to recover the bodies and has adopted the following memorial: "*Resolved,* That the Washington Biologists' Field Club has suffered a profound loss in the death of Mr. Joseph H. Painter. That the club has the highest admiration and respect for the noble character and heroic sacrifice for a younger companion, which appears to have led to Mr. Painter's untimely end. That the club extends its sincerest sympathy to the bereaved relatives."

M. CHARLES E. STUIVAERT, associate astronomer in the Royal Observatory of Belgium, died on November 18, at the age of fifty-seven years.

THE deaths are also announced of Dr. Hugo Hertzer, formerly professor of mathematics in the Berlin Institute of Technology, and of M. Charles Ballet, the French horticulturist.

THE fifth and sixth stories of the building in Washington in which the Geological Survey is housed were swept by fire on December 16, and serious loss by fire and water was suffered by collections, books, maps and field notes. This building is rented by the government; the need of a fireproof building for the Geological Survey has each year been pointed out by the director.

MR. J. C. CAMPBELL, president of the National Bank of Commerce, Columbus, Ohio, has provided a fund for lectures on scientific subjects to be delivered under the auspices of the Omega Chapter of the Society of Sigma Xi in Ohio State University.

THE Naples Table Association for promoting laboratory research by women announces that applications for the table at the Naples Zoological Station should be made by March 1, 1909. A prize of $1,000 for the best thesis written by a woman, on a scientific subject, embodying new observations and new conclusions based on an independent laboratory research in biological, chemical or physical science will be awarded for the third time in April, 1909. Further information may be obtained from the secretary, Mrs. A. D. Mead, 283 Wayland Avenue, Providence, R. I.

THE RESIGNATION OF PRESIDENT ELIOT

IN accepting with reluctance and keen regret the resignation of President Charles W. Eliot, of Harvard University, the overseers of Harvard College make this record of admiration and esteem:

Called to the presidency in early manhood, he has administered the affairs of this university for

forty years with eminent skill and fidelity. Its vast development during his term of service has been mainly due to his rare wisdom, his strong convictions, his enterprise and his zeal. Prompt to initiate reforms and fearless yet prudent in pressing them, he has by his constructive energy transformed Harvard College into a great university, and at the same time has exerted an influence on the educational forces of the nation which has largely shaped their policy, so that he stands to-day the leader in his age and generation.

Nor does Harvard alone attest his greatness. His mental precision and unusual capacity for lucid and apt discrimination have enabled him to treat public questions with singular authority and with an unerring instinct for the aspirations and needs of society. He has touched no subject without illuminating it; he has stood firmly for collegiate and civic righteousness; and so sane have been his counsels, so masterly his power of statement, that he not only commands to-day the attention of America, but he is honored by scholars and thinkers throughout the world. He has set an example to all by the simplicity of his life and by his absolute devotion to duty and the public interest. He lays down the cares of office voluntarily at the ripe age of seventy-five while "his eye is not dimmed nor his natural force abated." Indeed his temperament has mellowed with time, and he has grown young with the passing years.

This board, to every member of which association with him has been a privilege, congratulates him warmly on his long and distinguished service, and expresses the sincere hope that blessed with health he may enjoy for years to come the rest which he has richly earned and the honor freely accorded to him by a grateful community.

UNIVERSITY AND EDUCATIONAL NEWS

In a special report to President Schurman, Director V. A. Moore, of the New York State Veterinary College, asks the board of trustees of Cornell University to petition the New York State Legislature for appropriations amounting to $375,000 for improvements and additions to the Veterinary College. The following are the appropriations asked for in detail: (1) For maintenance for the college year 1909–10, $40,000, an increase of $10,000 over the present appropriation. The maintenance of this college as a teaching institution will soon require at least $50,000 per annum. (2) For research, experimental work and extension work, $10,000. This should be raised, as the work becomes organized, to $25,000. (3) For clinical buildings and equipment, $125,000. (4) For farriery, horseshoeing laboratory, stable for team and wagons, and fence, $50,000. (5) For the completion of the wing at the north end and the erection of the one at the south end of the main building, as originally planned, $150,000.

There are this year 403 students in the Graduate School of Arts and Sciences of Harvard University, distributed according to the divisions and departments under which their studies chiefly lie, as follows: Semitic, none; ancient languages, 26 (indic philology, none; classics, 26); modern languages, 121 (English, 80; German, 10; romance, 17; comparative, literature, 6; Scandinavian, 1; mixed, 7); history and political science, 75 (history and government, 46; political economy, 27; evenly divided, 2); philosophy, 48 (social ethics, 2); education, 10; fine arts, 6 (history and principles of the fine arts, 3; architecture, 3); music, 3; mathematics, 23; physics, 18; chemistry, 34; engineering, 1; biology, 18 (botany, 7; zoology, 11); geology, 6 (geology and geography, 4; mineralogy and petrography, 2); mining and metallurgy, 1; anthropology, 3. There are three students of the medical sciences and one of comparative philology, and four whose studies are miscellaneous.

Dr. C. A. Waldo, professor in Purdue University, has accepted the chair of mathematics at Washington University, St. Louis.

At Hobart College on the William Smith foundation, Mr. E. H. Eaton has been appointed professor of biology and Mr. F. P. Boswell assistant professor of psychology and mathematics. Mr. Ernest W. Dean has been appointed professor in chemistry.

The Medico-Chirurgical College of Philadelphia has established a department of pharmaceutic chemistry, of which Dr. George H. Meeker is the dean. Besides the professors and instructors drawn from the other faculties of the college, there have been added to the teaching force Professor F. A. Genth, as professor of mineralogy and assaying, and Pro-

fessor Charles E. Vanderkleed, as professor of pharmaceutic chemistry.

DISCUSSION AND CORRESPONDENCE

AFTONIAN SANDS AND GRAVEL IN WESTERN IOWA

TO THE EDITOR OF SCIENCE: During the past summer investigations made by the writer for the Iowa Geological Survey revealed widespread deposits of Aftonian sands and gravels in the western part of Iowa.

The beds, where undisturbed, in some cases reach a thickness of 35 feet, and furnish fine examples of cross-bedding and interbedding of sands and gravels. They lie unconformably between the Pre-Kansan and Kansan drifts, and were evidently deposited in flooded streams during an interglacial period.

That the climate of this period was comparatively mild is shown by the presence of fossil shells of species of mollusks still living in Iowa, belonging to the genera *Unio, Sphærium, Pisidium, Valvata, Planorbis, Ancylus,* etc., and of numerous bones and teeth of extinct herbivorous mammals belonging to the genera *Elephas, Mamut, Equus,* etc. The latter were found exclusively in the coarse gravels, while the former occurred chiefly in the finer sands.

At a number of points these sands and gravels were plowed and folded, and heaped up to a height of more than 100 feet above the Missouri Valley by the mass of Kansan ice which passed over them and in some cases even displaced the underlying Pre-Kansan.

The discovery is of special interest because these western gravels may now be definitely referred to the Aftonian, and because the fossils present a fauna practically new to that horizon, and throw light upon the climatic conditions which existed during the period of deposition.

B. SHIMEK

STATE UNIVERSITY OF IOWA,
December 14, 1908

SCIENTIFIC BOOKS

National Antarctic Expedition. Vol. IV., Zoology. London, British Museum, 1908. 4°, pp. 6, 279, and 65 plates. (Containing) *Solenogastres,* by H. F. NIERSTRASZ; *Aptera,* by G. H. CARPENTER; *Schizopoda,* by W. M. TATTERSALL; *Copepoda,* by R. NORRIS WOLFENDEN; *Echinoderma,* by F. JEFFREY BELL; Echinoderm larvæ, by E. W. MACBRIDE and J. C. SIMPSON; *Myzostomidæ,* by R. RITTER VON STUMMER-FRAUENFELS; *Sipunculidæ,* by W. F. LANCHESTER; *Actiniæ,* by J. A. CLUBB; *Tetraxonida,* by R. KIRKPATRICK; and *Calcarea,* by C. F. JENKIN.

Under the supervision of Mr. F. Jeffrey Bell, of the British Museum, another fine volume has been added to the series describing the scientific results of the expedition to the Antarctic under Captain Scott, R.N., and his companions. A brief reference to the subject-matter of the various memoirs is all that our space permits.

A single species of *Proneomenia* was obtained in about latitude of 78° S. This is described by Nierstrasz in great detail, followed by a proposed division of the family Proneomeniidæ into a large number of groups, based on the structure of the glands and radula. It may be heterogeneous, and the forms of which it is composed may be related to different members of the Proneomeniidæ.

Carpenter reports the presence of a wingless insect belonging to the Collembola in moss from Granite Harbor in 77° S. latitude, though the specimens were in rather imperfect condition. Enough was made out to allow placing it in a new genus, *Gomphiocephalus,* of the Poduridæ.

The Schizopod crustacea collected embraced considerably over ten thousand specimens, but of these the vast majority belong to a single species and the total number of species collected is only thirteen. The abundant material of the *Discovery* party enables Mr. Tattersall to combine under Dana's original name four subsequently described species taken from mutations due to age, or variability. Two species are cited as "bipolar" but further investigations of the deep sea may reveal them as cosmopolitan.

Of the Copepods seven proved new, and one new genus, *Paralabidocera,* is proposed by Wolfenden. Of the twenty-eight Antarctic species recognized, two are regarded as "bipolar," though many have Arctic an-

alogues. Twenty-five species were collected by the *Discovery*.

Among the small collection of echinoderms was the *Promachocrinus* first obtained by the *Challenger*, six Holothurians, two species of *Antedon*, three Echini, eight Starfishes, and ten or eleven Ophiurans. The collection of larvæ yielded the discovery of two pelagic forms and of the brood-pouch in *Cucumaria crocea*. A well-marked axial sinus and pore-canal in the *Cucumaria* embryo is of importance as definite evidence of a structure about which doubt had previously existed.

Two species of Myzostomidæ are treated in great detail. The sipunculoids comprise about thirty specimens which were all small and are considered as belonging to a single species of *Phascolosoma*.

The Actinians comprised six genera and eight species, of which six are Antarctic, two having been obtained at the Auckland and Falkland Islands.

The Tetraxonid sponges are exquisitely illustrated with colored plates of the finest quality.

There are six forms of Tetractonellidæ described, of which two are new varieties. The species are equally divided between the genera *Craniella* Schmidt, and *Cinachyra*. Of Monaxonellida there are forty-three species, with four new genera. Of the species, when obtained, twenty-two were new to science, besides seven new varieties.

The calcareous sponges collected comprise eighteen species and one variety, out of which six new genera and two new family groups have been constituted. All but five belong to the Heterocœla. In the discussion Jenkin proposes a new arrangement, founded in the main upon the classifications of Polejaeff and Dendy. The most interesting features of the collection are the large number of species containing chiactine spicules; five new species with "linked" flagellated chambers; a sponge, *Megapogon villosus*, with larger spicules than any hitherto recorded for a calcareous species; the unusual development of the gelatinous mesoderm in *Leucandra gelatinosa;* and the duplicate ovum, apparently a new form of egg cell in *Megapogon raripilus*, and *Achramorpha nivalis*. In the latter case the ovum appears to be made up of two unequal parts. The larger part is very similar to the ordinary large ovum cell and contains a large transparent nucleus and a small, strongly staining, nucleolus. The smaller part appears to be a multicellular structure, consisting of a large inner cell surrounded by a sheath of small cells, but it is possible it may be a single cell, the large portion being the nucleus. The inner cell contains two structures; one strongly staining like the nucleolus of the larger part, the other a hyaline sphere packed with about a dozen grains of one color, and an odd one which stains a different shade. The cells forming the outer layer have each a nucleus and a nucleolus. This layer, or sheath, in some cases surrounds the inner sphere completely, in others only surrounds the outer part, not existing between the inner spherical cell and the twin half of the ovum. It is possible that the smaller twin may be a feeding cell for the nourishment of the larger twin.

All the species of calcareous sponges were obtained at the winter quarters and in comparatively shallow water.

W. H. Dall

Hygiene and Public Health. By Louis C. Parkes, M.D., D.P.H., University of London, and Henry R. Kenwood, M.B. Edin., D.P.H., London. Third Edition with Illustrations. 8vo, pp. 620 with 96 illustrations. Philadelphia, P. Blakiston's Son & Co. 1907.

The third edition of this valuable work under the conjoint authorship has been carefully revised and brought up to date. The book is divided into thirteen chapters and deals in a very comprehensive way with Water; The Collection, Removal and Disposal of Excretal and Other Refuse; Air and Ventilation, Warming and Lighting; School Hygiene; Soils and Building Sites; Climate and Meteorology; Exercise and Clothing; Food, Beverages and Condiments; The Contagia; Communicable Diseases and Their Prevention; Hospitals—Disinfection; Statistics; Sanitary Laws and Administration.

In the chapter on water, it is noteworthy that some of the large cities in Great Britain are rapidly following the example of ancient Rome to bring pure water from quite a distance. So, for example, Glasgow is supplied with water from Loch Katrine, thirty-four miles north of the city. Manchester has recently obtained a new source of supply from Thirlmere, ninety miles from the city, and by the construction of a dam the level of the lake has been raised and its storage capacity increased. Liverpool by immense engineering works has impounded the waters of the Vyrnwy in Wales. The work involved the construction of a massive masonry wall across a narrow part of the valley, creating an artificial reservoir four and three fourths miles in length and conveying the water a distance of sixty-eight miles.

Birmingham is likewise engaged in the task of bringing water from the upper sources of the Wye. There can be no question as to the sanitary and economic effects of these changes. It is well known that the greatest reduction in typhoid-fever rates has everywhere been accomplished when a pure water supply has been substituted for a previously contaminated one.

The vital statistics of our own country as analyzed by the present writer in his address on the "Conservation of Life and Health by Improved Water Supply, White House, 1908," show that the combined average death rate from typhoid fever in cities with a contaminated water supply was 69.4 and after the substitution of a pure supply it fell to 19.8 per 100,000, a reduction of 70.5 per cent. The reduction in ten cities in the state of New York, according to a paper published in the Bulletin of the New York State Department of Health, April, 1908, amounted to 53.4 per cent. One of the tables based upon data obtained from Dr. Wilbur, of the Division of Vital Statistics, U. S. Census Bureau, shows that during the last twenty-five years the death rate from typhoid fever has fallen in fourteen countries and large cities from an average of 42.3 to 18.1 per 100,000, a reduction of 54.3 per cent. It may be urged that improved methods of medical treatment are responsible for a considerable reduction in the death rates, but when we see such a striking change immediately after the installation of filtration plants as in the case of Albany, Watertown, Lawrence and Cincinnati, we are forced to the conclusion that water purification plays the most important rôle. We note that the authors still quote 27.08 gallons of water as a fair daily average per capita consumption. In most of our American cities the per capita consumption for household, trade and manufacturing and municipal purposes is three to four times greater.

The chapter on the collection, removal and disposal of excretal and other refuse is very complete, as are most of the English textbooks on the subject. Attention is directed in the comparison of methods on page 81 to the fact that in Nottingham, where middens, pails and water closets are in use in different parts of the town Dr. Boobbyer has shown that the greatest prevalence of enteric or typhoid fever is to be found in the houses with middens and the least in the water closeted houses, those with pails occupying an intermediate position. In 1902 there were thrice as many cases of enteric fever proportionately in "pail" houses as in "w. c." houses, and fourteen times as many in "midden" houses as in "w. c." houses.

The writer in 1895 in his typhoid fever investigation in Washington observed similar facts and offered as an explanation that the sewers carry away the filth which otherwise would be a source of danger chiefly through the agency of flies, who may carry the germs on their feet and infect the food supply of neighboring houses.

The value of pure air and outdoor life is pointed out on page 169, by referring to Dr. Ogle's researches which have shown "that of all the industrial classes, those which are the healthiest and have the lowest death rates are the gardeners, farmers, agricultural laborers and fishermen—those namely, whose occupations are carried on in the open air. The death rate from phthisis in these cases is only half that of the male community generally, and they enjoy about the same amount of

freedom from diseases of the respiratory organs. Differences in food or housing accommoderations can not account for the comparative freedom of these classes from pulmonary disease."

The causal relation of foul air to tuberculosis is shown by the fact that since the British government has payed attention to air space and ventilation the death rate from consumption among the soldiers, sailors and prisoners which was formerly excessive is now considerably less than among the civil population.

The dangers of sewer air are being revived again by recent experiments of Horrock's at Gibraltar, which gave results at variance with those obtained by Laws and Andrews. He found that specific bacteria present in sewage may be recovered from the air of drains and sewers, even when the sewage is flowing smoothly and without splashing. He believes that they may be ejected into the air by: (*a*) the bursting of bubbles at the surface of the sewer, (*b*) the separation of dried particles from the walls of the sewers and pipes, and probably (*c*) by the ejection of minute droplets from flowing sewage.

A similar explanation was offered by Uffelmann over twenty years ago and Horrock's experimental data, which also showed that the disconnecting trap on a house drain prevents the passage of bacteria present in sewer air into the house drains, will naturally tend to revive the opinion, formerly held, that sewer and drain air may be the means of spreading infectious diseases unless the house drain and fixtures are properly trapped.

The section on vitiation of air in industrial occupations is very complete and the table on page 182, giving the comparative mortality figures for males engaged in different dust-inhaling occupations shows conclusively that the hard, sharp and angular fragments of mineral and metallic dust are especially calculated to cause irritation and abrasions of the respiratory passages and thus favor the invasion of the tubercle bacillus and also the production of other diseases of the respiratory organs in general.

The book is accurate and up to date in every respect and can be confidently recommended to all interested in hygiene and public health.

George M. Kober
Georgetown University

Soils and Fertilizers. By Harry Snyder, Professor of Agricultural Chemistry and Soils, University of Minnesota. Third edition. 8vo, 350 pp. New York, The Macmillan Company. 1908.

The first edition of Snyder's book, then entitled "Chemistry of Soils and Fertilizers," was at the time of its publication in 1899 a most welcome addition to the libraries of teachers of agriculture. It gave in logical and systematic form a brief course in agricultural physics and chemistry, and in the practise deducible therefrom, and was widely used in our agricultural colleges by both students and teachers. But the rapid advance of agricultural science made it advisable to publish a revised second edition in 1905, without, however, materially increasing the length of the text. In the new, third edition we have instead of the 287 pages of the previous editions, 344 pages, slightly smaller than before.

The increase is partly due to the addition of illustrations, as in the excellent chapter on laboratory practise, which has been enlarged from 13 to 19 pages, and forms one of the most useful features of the book for the guidance of teachers, who often fail to illustrate the facts and principles of their course in a manner both attractive and profitable to their students. Many of these experiments and apparatuses are original with Snyder, and very cogent. The twelve pages of review questions, also, are very well calculated to impress upon the student the practical applications of what is brought before him during his course, and to induce attention in advance of the final examination, in place of the "cram" so commonly indulged in at the end of the session.

The body of the text itself has been thoroughly revised so as to include the results of the latest researches in the agricultural field, and one recognizes plainly the ring of the diction of one who knows whereof he speaks from personal investigation. This influence, difficult to define exactly, is nevertheless most

potent in securing the interest and attention of students, who instinctively recognize the difference between the teacher who merely transmits what others have said and done, and the one who as an active investigator has increased the store of knowledge.

Snyder's important researches on humus and the nitrogen of soils are well summarized and render this portion of the book especially valuable and complete, in showing quantitatively the increase and decrease of nitrogen under different methods of culture, largely on the basis of investigations made by the author himself. The entire subject of soil fertility and fertilization is so comprehensively yet briefly treated, that while nothing really essential is omitted, one is forcibly struck with the immensity of the field, and the total inadequacy of the time and preparation usually bestowed upon it even by those who are attempting to prepare themselves to be active workers in experiment stations. The one-sidedness and narrowness of the ordinary course of preparation for such activity is strongly emphasized by what, for brevity's sake, Snyder has to leave unsaid in this excellent book. But the practical applications of the facts and principles given are so well interwoven with the latter that "a peg is struck" in connection with each, in the mind of the reader or student, and will strike the practical farmer as well. To both classes of readers, and more especially to teachers of agriculture, this volume will be most welcome and useful.

Intended as the book is mostly for the temperate humid region, its omissions as concerns the arid region and the tropics are perhaps not a fair subject for criticism. The index is somewhat scantier than it should be for convenience of reference, when such subjects as alluvium, subsoil, leaching of soils, root penetration and others of similar importance, can not be conveniently located by its aid.

E. W. HILGARD

The New Physics and Its Evolution. By LUCIEN POINCARÉ. Authorized translation. Pp. 344. New York, D. Appleton & Co. 1908.

Professor Poincaré says in his preface:

> It has occurred to me that it might be useful to write a book which, while avoiding too great insistence on purely technical details, should try to make known the general results at which physicists have lately arrived, and to indicate the significance of the recent speculations on the constitution of matter and of the recent discussion of first principles.

One of the most interesting things to the physicist in this book is the author's insistence on the atomic theory as a fundamental principle which he would place on a par with the principle of the conservation of energy and the principle of Carnot and Clausius (the second law of thermodynamics). Indeed, it may be said, using the author's words, that the atomistic synthesis, but yesterday so decried, is to-day triumphant.

Professor Poincaré is one of the leading exponents of the view, which has always been held by the experimentalist, that the truth of a theory is solely its availability for use, and the value of Professor Poincaré's recent books lies to a great extent in the manner in which he sets this view before that great body of insistent and shameless theorists, the general public.

The scope of Professor Poincaré's book is sufficiently indicated by the above extract from his preface, and its quality is sufficiently indicated by the statement that it has an interest to the physicist and a value to the general reader. Let us, therefore, return to the paradoxical statement concerning the general public, our persistent and contented theorists, and let us illustrate by taking an example which every one should be able to appreciate. It is very well for a sailor, perceiving that the wind blows, to set his sails accordingly; and he usually knows well how to do it. But a sailor's grandson who sets himself to studying the wind, let him be careful how he uses the idea which pervades this simple perception.

> Even the apparently steady flow of a great river is an endlessly intricate combination of boiling and whirling motion; and the jet of spray from

a hydrant, or burst of steam from the safety valve of a locomotive, what is to be said of such things as these? Or let one consider the fitful motion of the wind as indicated by the swaying of trees or as actually visible in driven clouds of dust and smoke; or the sweep of the flames of a conflagration! Let one think of these things and consider whether it is not necessary to bring the mind to some narrow view before any clear line of argument can be pursued relative thereto.

Yes, it is necessary, and the simple idea of flowing, or, to put it in the usual way, the *idea of simple flow,* when properly and precisely defined[1] constitutes the basis of the science of hydraulics; but the general public is so content with ideas (theories) that they project them unreservedly into objectivity and that ends the matter in their minds. The wind blows and water flows, they say, and if one objects they claim that by blowing they mean *what the wind actually does,* although they admit they do not *know* it all. Maybe that is what they do mean, but such symbolism is worse than useless in science. A physical theory, or let us say rather, for the sake of intelligibility, a physical idea has in every case a *structural* content which represents more or less completely a condition or thing and you *do* know it all. A physical theory is, in fact, a working model in one's head such as the kinetic theory of gases, or the wave theory of light.

The general public indeed are not only content with simple practical ideas such as the idea that the wind blows, but they are theorists also in a weak and contemptible sense, so many of them learn elaborate theories which they never use—and think themselves fine. It is a good thing, this recent talk about truth's being availability for use, and many intelligent people would be surprised indeed if they could understand to what extent this axiom has been driven into scientific men.

But let us go back to the man who says that the wind blows and who thinks he has in mind what the wind actually does, and let us consider whether this man's interest is in the kinematics of the atmosphere or in the deeply laid plans of men which the wind *undoes* in havoc and disaster. Can there be any doubt as to what his interests really are, and as to what he really has in mind? It is little indeed that most men know of that remarkable quality of science, the quality of detachment. Science leaves human values mostly to art and to the arts, and the symbolism of the artist and of the business man is very different from the symbolism of science. It would seem, indeed, that art and business procedure can project themselves unreservedly into objectivity and stand unabashed; but with science it is not so. The ideas of flowing and blowing are true because the sailor and the lock-tender use them and they work; but the subtlety of nature is far beyond that of sense or of the understanding, and to project such simple ideas unreservedly into objectivity is to make an end to science.

There is at the present time a general awakening in philosophy and many scientific men seem to think that the world-wide talk on pragmatism is simply the first, long-delayed response of the great mass of men to the compelling philosophy of the experimental sciences, but it seems to the writer that this is by no means a complete diagnosis of the situation because some of the most striking features of the present philosophical movement are to be found in the transformation or reversion which the philosophy of the exact sciences is now undergoing. A period of remarkable activity in the physical sciences has been followed by a revolution in the conduct of business and industry, impressing the methods of the physical sciences upon great numbers of men, and the reciprocal effect is a growing domination of the exact sciences by a spirit of humanism, as pragmatism has been called in England. Indeed, the changes which human interests as a whole are creating in the philosophy of the exact sciences

[1] See pages 219–221 of Franklin and MacNutt's "Elements of Mechanics," The Macmillan Company, 1907. This book is unique as an attempt to supplement precision of ideas and definitions (with due deference to the reviewer in *Nature,* who says the book is very inaccurate and has no reason to be) with suggestive allusions to the subtleties of nature in order to fortify the student against the confusion of boundaries between our logical structures and the objective realms of reality, a confusion which, to use Münsterberg's phrase, is "the gravest danger of our time."

are no less profound and significant than the changes which the physical sciences have brought about in the conditions of human life.

The change which is taking place in the philosophy of the exact sciences is many sided, but a prominent feature of it is the passing away of an old point of view, namely, that nature is exact and unvarying, that the so-called laws of the physical sciences are ultimate realities, and that great simple facts of the physical universe are revealed in their perfection, one after another, to the divining spirit of mankind. It is not easy, however, to characterize the point of view which is now becoming dominant. In one way it may be described as a reenthronement of sense, and it may be exemplified by contrasting what is said above with the point of view of the author of one of our best modern engineering treatises on hydraulics as indicated by the following extract: "Galileo said in 1630 that the laws *controlling* the motion of the planets in their celestial orbits were better understood than those *governing* the motion of water on the surface of the earth. This is true to-day, for *the theory of the flow of water in pipes and channels has not yet been perfected.*" [Italics ours.] No! and it never will be Perfected! It would take too long to explain here just what is meant by this declaration, for, indeed, it has nothing to do with the fool idea, if, indeed, it can be called an idea, that "the finite can not comprehend the infinite" so that "we may not presume to point out all the ways in which a God of unbounded resources might govern the universe." From such inanity may the great God of little things deliver us!

Every student should realize two things in connection with his study of the physical sciences. The first is that the study of the physical sciences is exacting beyond all compromise, and the second is that the completest science stands abashed before the infinitely complicated array of phenomena of the material world except only in the assurance which its method gives.[2]

The new physics! Let no one imagine that what he calls results (which are in nearly every case, and especially in the popular mind, a more or less shameless projection of ideas into objectivity) constitute the new physics. The readiness with which the physicist can nowadays meet a new group of observable effects with adequate instrumental and theoretical tools is strikingly exemplified by the recent work in radioactivity. This facility of the modern scientific method in the realm of the physical sciences *is* the new physics, it is a realization of what Bacon long ago listed as one of the deficiencies of knowledge, namely, the Art of Inventing Arts, and the very essence of it is an increased realization of the fact that ideas are not things. Boundaries are no longer confused.

W. S. FRANKLIN

November 22, 1908

[2] Taken from a paper on "The Study of Science by Young People," *New York State Education Department Bulletin*, No. 431, pp. 65–94, September, 1908.

SCIENTIFIC JOURNALS AND ARTICLES

IN *The American Naturalist* for November Thos. H. Montgomery gives the results of "Further Studies on the Activities of Araneads," dealing with questions of the snares, senses of touch and sight, and the average duration of life. To some it will seem a pity that the term Araneids was not used, since this termination has been much used by zoologists. Floyd E. Chidester has "Notes on the Daily Life and Food of *Cambarus bartonius bartoni*," and Austin H. Clark describes "Some Points in the Ecology of Recent Crinoids," noting some of the factors that influence their size and distribution. Shorter articles are "Evolution Without Isolation" and "A Note on the [Spawning] of the Silverside." The book reviews are unusually full and important, especially those on "The Origin of a Land Flora" and "The Animal Mind."

The American Museum Journal for December contains an illustrated article on the "Exhibit Illustrating the Evolution of the Horse" in which it is noted that the American Museum collections of fossil horses are larger than those of all other museums put together. The "Department of Mineralogy" records the reception of what is probably the largest mass of polybasite ever taken from a mine. It is announced that the "Tuberculosis Exhibit" installed in the new wing on Columbus Avenue, will remain open for several weeks.

The Museum News of the Brooklyn Institute notices the installation of an exhibit illustrating Mr. Abbott H. Thayer's principles of obliterative shading, of a group of timber wolves and of a large painting showing the appearance of a coral reef. The main article in the Children's Museum section describes coffee culture in Guatemala.

SPECIAL ARTICLES

THE DETERMINATION OF THE CLAY CONTENT OF SOILS[1]

In the method of mechanical analysis of soils originally devised and used in the Bureau of Soils of the United States Department of Agriculture,[2] the amount of clay was determined—after the coarser particles had been separated by centrifuging—by evaporating the clay-water to small bulk in enameled-ware sauce pans, transferring it to platinum, carrying completely to dryness, and weighing the residue. This method was found undesirable on account of the excessive time required for the evaporation, because many dust particles and fragments cracked from the lining of the sauce pans got into the clay and were weighed with it, and because the transfer from sauce pans to platinum required much time and trouble and offered possibilities of loss. To avoid these difficulties, and especially to increase the rapidity of the work, it was therefore decided to abandon the final transfer to platinum, and to complete the evaporation in the enameled-ware dishes and weigh the clay in them without transfer. For convenience in weighing and to decrease the likelihood of entry of dust, the enameled-ware sauce pans were discarded and there were adopted instead much smaller enameled-ware cups, having a capacity of about 300 c.c. and weighing about 180 grams. This method has the disadvantage of requiring a much heavier balance, but the determinations seem none the less accurate, and a great saving of time has been effected.

It is now thought that the method may be still further shortened in the case of routine analyses by abandoning altogether the direct determination of clay and obtaining its percentage by difference. The error thus introduced will probably be far less than that involved in the centrifugal (or other) separation of the clay from the silt, and both errors are almost certainly within the limits of variation which may be expected between different samples of the same soil. In one hundred consecutive analyses taken at random from the recent files of the Bureau of Soils the variations between the percentage of clay as directly determined and that found by difference ranged between 0 and 2.28 per cent. In two cases the variation was over 2.00 per cent.; in three cases, between 2.00 per cent. and 1.50 per cent.; and in six cases between 1.50 per cent. and 1.00 per cent. In all other cases the variations were 1.00 per cent. or less.

It is indeed not improbable that in many cases the determination by difference is the more accurate, as all errors due to access of dust or to loss of clay water are thus avoided. Errors due to a not impossible change in the state of hydration of the clay are also eliminated. It is believed that in the vast majority of cases the difference method in clay determination will be accurate within 1.00 per cent., and no greater accuracy is necessary or even desirable for purposes of soil classification. The saving in time is at least 30 per cent., and is believed to be well worth while in routine laboratories making a large number of analyses. The direct determination must, of course, be retained for cases of especial importance, or where a check is necessary and is probably also advisable for students' use, and for use in small laboratories.

C. C. Fletcher

Bureau of Soils,
U. S. Department of Agriculture

[1] Published by permission of the Secretary of Agriculture.

[2] See Bulletin No. 24, Bureau of Soils, U. S. Department of Agriculture (1904).

NOTES ON THE ATROPHY OF THE EYE OF RAJA ERINACEA

In the skate, *Raja erinacea*, a clearly defined case of complete atrophy of the left eyeball was observed in our course this fall.

The brownish integument continued without

any marked change over the region of the eye, the only indication of the place where the eye should be being a slight absence of pigment and a more delicate texture. When the dorsal integument was removed, no evidence of an eyeball was to be noted. The optic pedicel was present and in a normal condition as to both size and position. The several recti muscles were recognized with difficulty. Their origin was as in the right eye, but they were inserted into loose connective tissue surrounding the optic pedicel with their fibers from 2 to 5 mm. long. The fibers in the recti muscles of the right eye were 10–15 mm. long, which indicates something of the amount of degeneration of the recti muscles in the atrophied eye.

The trochlear, oculo-motor and abducens nerves were each found piercing the cranial capsule and passing to the short and mostly fused recti muscles. So far as one could determine by a gross examination, these nerves were the same as those passing to the fully developed eye, except much shorter. The optic nerve was surrounded by a greater amount of connective tissue than in the normal eye and terminated distally and abruptly at the end of the optic pedicel, with which it was closely united.

Two explanations are suggested for the disappearance of this eye. First, the loss of the eyeball was due to some injury. If such were the cause, then one would expect to find some evidence in the form of a scar, etc., but nothing was seen which pointed conclusively to any previous injury. Secondly, for some reason of which we have no knowledge, the embryonic eyeball tissues were arrested in their development. This seems the more probable as the integument over the eye was so much like the rest of the skin. The material was not fixed satisfactorily for a histological study.

W. M. SMALLWOOD

ZOOLOGICAL LABORATORY,
SYRACUSE UNIVERSITY

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at the Johns Hopkins University, at Baltimore, during convocation week, beginning on December 28, 1908:

American Association for the Advancement of Science.—Retiring president, Professor E. L. Nichols, Cornell University; president-elect, Professor T. C. Chamberlin, University of Chicago; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. J. Paul Goode, University of Chicago.

Local Executive Committee.—William H. Welch, M.D., chairman local committee; Henry Barton Jacobs, M.D., chairman executive committee; William J. A. Bliss, secretary, Joseph S. Ames, William B. Clark, R. Brent Keyser, Eugene A. Noble, Ira Remsen, John E. Semmes, Francis A. Soper, Hugh H. Young.

Section A, Mathematics and Astronomy.—Vice-president, C. J. Keyser, Columbia University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Professor Carl E. Guthe, State University of Iowa; secretary, Professor A. D. Cole, Ohio State University, Columbus, O.

Section C, Chemistry.—Vice-president, Professor Louis Kahlenberg, University of Wisconsin; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor Geo. F. Swain, Massachusetts Institute of Technology; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E, Geology and Geography.—Vice-president, Bailey Willis, U. S. Geological Survey; secretary, F. P. Gulliver, Norwich, Conn.

Section F, Zoology.—Vice-president, Professor C. Judson Herrick, University of Chicago; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor H. M. Richards, Columbia University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Professor R. S. Woodworth, Columbia University; secretary, George H. Pepper, American Museum of Natural History, New York City.

Section I, Social and Economic Science.—Vice-president, Professor W. G. Sumner, Yale University; secretary, Professor J. P. Norton, Yale University, New Haven, Conn.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor Wm. H. Howell, Johns Hopkins University; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Professor John Dewey, Columbia University; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Society of Naturalists.—December 31. President, Professor D. P. Penhallow, McGill University; secretary, Dr. H. McE. Knower, The Johns Hopkins Medical School, Baltimore, Md. *Central Branch.* President, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society.—December 30, 31. President, Professor H. S. White, Vassar College; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 28, 29. President, H. W. Tyler, Boston, Mass.; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Physical Society.—President, Professor E. L. Nichols, Cornell University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 29–January 1. President, Professor Marston T. Bogert, Columbia University; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Geological Society of America.—December 29, 31. President, Professor Samuel Calvin, University of Iowa; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—January 1, 2. President, Dr. G. K. Gilbert, U. S. Geological Survey; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Society of Vertebrate Paleontologists.—December 28–30. President, Professor Richard Swan Lull, Yale University; secretary, Dr. W. D. Matthew, American Museum of Natural History, New York City.

The American Society of Biological Chemists.—December 28–30. President, Professor John J. Abel, The Johns Hopkins University; secretary, Professor William J. Gies, 437 West 59th St., New York City.

The American Physiological Society.—December 29–31. President, Professor W. H. Howell, Johns Hopkins University; secretary, Dr. Reid Hunt, Hygienic Laboratory, 25th and E Sts., N. W., Washington, D. C.

The Association of American Anatomists.—December 29–31. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–January 2. Vice-president, Professor H. L. Russell, University of Wisconsin; secretary, Dr. Norman MacL. Harris, University of Chicago, Chicago, Ill.

The American Society of Zoologists.—Eastern Branch, December 29–31. President, Professor William Morton Wheeler, Harvard University; secretary, Dr. Lorande Loss Woodruff, Yale University, New Haven, Conn. *Central Branch*, December 28–30. President, Professor E. A. Birge, University of Wisconsin; acting secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The Entomological Society of America.—December 29, 30. President, Professor W. M. Wheeler, Harvard University; secretary, J. Chester Bradley, Cornell University, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor S. A. Forbes, University of Illinois; secretary, A. F. Burgess, Washington, D. C.

The Botanical Society of America.—December 29–31. President, Professor W. F. Ganong, Smith College, Northampton, Mass.; secretary, Professor D. S. Johnson, Johns Hopkins University, Baltimore, Md.

American Nature Study Society.—December 30, 31. President, Professor L. H. Bailey, Cornell University; secretary, Professor M. A. Bigelow, Teachers College, Columbia University, New York City.

Sullivant Moss Chapter.—President, Dr. T. C. Frye, Seattle, Wash.; secretary, Mr. N. L. T. Nelson, St. Louis, Mo. Address: Mrs. Annie Morrill Smith, 78 Orange St., Brooklyn, N. Y.

Wild Flower Preservation Society.—President, Professor Chas. E. Bessey; secretary, Dr. Charles Louis Pollard, New Brighton, N. Y.

The American Anthropological Association.—December 28–January 2. President, Professor Franz Boas, Columbia University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 28. President, Professor Roland B. Dixon, Harvard University; secretary, Dr. Alfred M. Tozzer, Harvard University, Cambridge, Mass.

The American Psychological Association.—December 29–31. President, Professor G. M. Stratton, University of California; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

The American Philosophical Association.—December 29–31. President, Professor Hugo Münsterberg, Harvard University; secretary, Professor Frank Thilly, Cornell University, Ithaca, N. Y.

Southern Society for Philosophy and Psychology.—Convocation week. President, Professor J. MacBride Sterrett, The George Washington University; secretary, Professor Edward Franklin Buchner, The Johns Hopkins University, Baltimore, Md.

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 208th meeting of the society, held at the Cosmos Club, on Wednesday evening, October 28, 1908, under informal communications, Mr. J. S. Diller discussed briefly wind-blown grains of quartz in limestone.

Regular Program

Geologic Studies in Southwestern Alaska: Mr. WALLACE W. ATWOOD.

The island of Unga, a portion of the Alaskan Peninsula north of Unga in the vicinity of Balboa and Herendeen bays and a district in the vicinity of Chignik Bay were visited during the past summer with a view to determining the stratigraphy of the coal-bearing horizon. The island of Unga was found to consist chiefly of igneous rocks. On the north end of the island there are some lignite-bearing beds that immediately underlie Miocene sediments. The lignite-bearing beds have been determined on the basis of plant remains to belong to the Kenai horizon. Small patches of Miocene were found at various localities on Unga, Popof and the mainland.

In the Balboa-Herendeen Bay district a thickness of over 5,000 feet of sediments was found from which Eocene shells and Kenai plants were secured. The beds which yielded the marine shells were interstratified with the leaf-bearing beds in a conformable series. This great series of Eocene beds was traced eastward through the central portion of the peninsula to Chichagof Cove, where Dr. Palache secured marine Eocene shells. The age of the Kenai leaves has been a confusing problem in Alaska and the association of these leaves with marine shells is very gratifying. The Eocene belt has been folded and faulted and large masses of granitic rock have been intruded into it. These intrusions are in the forms of dikes, sills and laccoliths. North of the Eocene belt formations of Upper Jurassic, Lower and Upper Cretaceous were found. The Herendeen Bay coal field is located in the Cretaceous area and the coal is of Upper Cretaceous age. The structural relationship between the Upper Jurassic and Lower Cretaceous is that of conformity. Between the Lower Cretaceous and the Upper Cretaceous there is a faunal break, but no structural break was found at that horizon. Between the Upper Cretaceous and Eocene beds there does not appear to be any structural break but the faunal material received is not complete. Near the close of the Eocene times there were igneous intrusions, volcanic outbreaks and deformation. Miocene beds rest, at most places, unconformably upon underlying formations, although on the north end of Unga Island sedimentation was continuous from the Eocene on into the Miocene times.

Since the Miocene beds were deposited there has been further deformation and vulcanism in the region and volcanic activity has continued up to the present time.

The work in the Chignik district consisted chiefly in an examination of the coal field. The faunal material from that area has not yet been examined, but it is expected that the same horizons that were found in the Herendeen Bay district are represented in the Chignik area. Fossil shells and plants are there closely associated and it is expected that further light on the Kenai problem will be afforded by the collections secured from that place.

New Occurrence of Willemite and Anhydrite: Mr. W. LINDGREN.

Anhydrite occurs in the Cactus mine at Newhouse, southern Utah. The mineral accompanies the chalcopyrite of that copper mine as a primary gangue mineral and is associated with tourmaline and a small amount of calcite and siderite. The hydration of the anhydrite results, of course, in the formation of gypsum, which mineral is abundantly found throughout the mine.

Willemite as a commercially important mineral of zinc ores is mined at Tres Hermanas in southern New Mexico. The mineral forms dense masses consisting of slender hexagonal prisms, and is associated with calcite, a little smithsonite, and calamine, as well as hydro-zincite. The occur-

rence is in the oxidized portion of a contact metamorphic deposit in limestone at the contact with quartz-porphyry. A number of carloads of this mineral were shipped in 1905. The mineral was identified by analysis.

Lines of Inference in Paleogeographic Studies: Mr. Bailey Willis.

The primary difficulty in attempting to draw a map of North America, for example, to represent the continent as it was during a given period, is to select facts which may be assumed to have had approximate synchronism. The New York Trenton, for instance, can not be narrowly correlated with an equivalent in the Mississippi Valley region or in the Nevada basin, even where the sequence of Ordovician strata is unbroken and the Trenton interval is represented by some part of the sediments. Hence, in treating a large area, it becomes necessary to accept approximate correlations and to present a sequence of geographic changes or a tendency toward a certain geographic state, rather than a definite state which may have been attained at a definite time. The data of paleogeography are: (1) the criteria of overlap and shore sediments to determine coasts; (2) the distribution of marine sediments to determine known seas; (3) the arrangement of oceanic depths, negative continental elements and positive continental elements, to determine possible extensions of the more or less probable lands and seas.

From this consideration of stratigraphic data there results in any case a certain possible distribution of lands and seas which may be tested in the following manner. Under the supposed conditions and under general laws of atmospheric and oceanic circulation, ocean currents presumably took certain courses. If the lithologic and faunal facies of marine deposits (local modifying influences apart) are determined primarily by oceanic currents and distributed accordingly, then the courses of the currents deduced from the supposed arrangement of lands and seas should lead to a distribution of facies corresponding broadly with the observed deployment of facies over the continent.

Applying these criteria to a definite problem, it is suggested that the marine circulation during Trentonian time developed into a central epicontinental current, which flowed northward from the Gulf of Mexico; bathed the shores of Colorado on the west and Appalachia on the east; spread around the Ozark and Wisconsin islands, and penetrated across the Laurentian region to the Arctic. Return currents flowed southward along the St. Lawrence and Champlain trough and continued along the shore of Appalachia between the northward-flowing current and the land and their effect extended to Alabama and Arkansas. A similar current flowed south along the trough of the Rocky Mountains in British Columbia at least as far as the forty-ninth parallel. The distribution of two very distinct Ordovician facies, the Galena-Trenton and the Normanskill facies, appears to correspond with the deductions regarding currents.

Philip S. Smith,
Secretary

THE TORREY BOTANICAL CLUB

The first meeting of the season, held at the Museum of Natural History, on October 13, 1908, was called to order at 8:20 P.M. by Dr. Howe in the absence of other officers. Mr. George V. Nash was elected chairman. There were fourteen persons present. The resignation of Dr. C. Stuart Gager as secretary of the club, occasioned by his removal to the University of Missouri, was read, and accepted with regret, after an expression of the value of his services to the club.

The scientific program consisted of informal reports on field observations by members. Professor F. E. Lloyd was called upon first and spoke of his recent experiences in Mexico. He exhibited field notes and photographs of cacti collected largely in northern Zacatecas, Mexico; in a restricted region, about sixty species are found. Four species of *Opuntia* are reported to be new: there were no species of *Echinocereus*. Owing to the fact that cacti in conservatories often exhibit very different behavior from that in their natural habitat, the importance of such field study of the group is to be emphasized.

Professor Lloyd then spoke on the bionomics of *Parthenium argentatum*, known in Mexico as guayule. From this plant a large amount of commercial rubber is obtained; the rubber occurs in masses in cells of the pith, medullary rays and cortex, and is extracted by mechanical means. In addition to reproducing freely by seed, there is an interesting method of vegetative reproduction. The plant has, besides a tap-root system, long and slender horizontal roots near the surface, from which new shoots arise and produce new plants at a distance of a meter or more from the main plant. There may be from two to six of these shoots arising from one point, producing such a different habit that such plants may be

easily distinguished from the seedlings with their single trunk. A piece of the stem of *Landolphia*, a tropical liana, was exhibited. In this case the latex coagulates in the canals and the rubber is extracted by mechanical means.

Mr. R. S. Williams spoke briefly of his five months' experience in Panama, particularly on the climatic and soil conditions as affecting vegetation.

Dr. E. B. Southwick exhibited a peculiar monstrosity of *Zea Mays*. Mr. Nash reported the discovery of the rare orchid, *Epipactis viridiflora*, at Letchworth Park.

TRACY E. HAZEN,
Secretary pro tem.

THE meeting of October 29, 1908, was called to order at the New York Botanical Garden at 3:30 P.M., Dr. M. A. Howe being asked to take the chair. Mr. Percy Wilson was elected secretary.

A microscopic preparation of the red snow plant, *Sphærella nivalis*, collected this autumn on Cape York, Greenland, was exhibited by Dr. N. L. Britton, who received it from the secretary of the Peary Arctic Club. Dr. Tracy Hazen gave a brief description of this interesting plant and raised certain questions still unsolved concerning it.

The first subject on the published program was "A Recent Collection of Mosses from Panama," by Mr. R. S. Williams. The following synopsis of this paper was written for the secretary by Mr. Williams:

"For the time spent in the field this was much the smallest collection of mosses ever made by the speaker. It may be accounted for partly by the fact that most of the work was done in the latter part of the dry season, namely, during the last week of February, through March and about three weeks of April, and partly because of the low level, mostly under 300 feet elevation, at which much of the collecting was done.

"In the city of Panama are a number of fine old ruins more or less overgrown with shrubs and smaller plants, but not a single species of moss was observed. On going to Penonome, some hundred miles west of the Canal Zone on the Pacific coast the conditions were found to be much the same. One species of moss, however, was found abundantly fruiting in a cultivated field of cassava. This was *Bryum coronatum* Schwaegr., a world-wide species of the tropics and occurring as far north as Florida. On going a few miles back of the town among the foothills and low mountains, various mosses become not uncommon, growing chiefly on trees, but even here very few species were obtained in anything like good fruiting condition. On leaving Penonome a trip was made southeast of the canal along the Pacific coast about 100 miles to the Gulf of San Miguel and up the Tuira River about 70 miles into the interior to the mining camp of Cana. Here much more favorable conditions were found, Cana being situated at an altitude of 2,000 feet above the sea with the Espirito Santo Mountains just back of the town rising 5,000 feet higher. Mosses and liverworts were fairly abundant and at a more favorable season doubtless a large collection might be made.

"Of the thirty species brought back from both sides of the Canal Zone, five sixths are known to be South American. Two of these, *Pilotrichum amazonum* Mitt., collected originally by Spruce on the Amazon, and *Lepidopilum brevipes* Mitt., found by Spruce in the Andes at 3,000 feet, had not been since reported by any other collector. The five remaining species appear to be unknown outside of Central America. They are *Syrrhopodon Bernoullii* C.M.; a species belonging to the very large genus *Macromitrium*, apparently undescribed; a species of *Cryphæa*, also undescribed, and bearing numerous propagula on the stems; *Porotrichum cobanense* C.M. and *Cyclodictyon Liebmanni* Schimp., these last two being previously known only from the type localities."

The second announced paper, "The Morphology of *Tænioma*," by Miss Elizabeth I. Thompson, was not read, Miss Thompson being absent.

Dr. N. L. Britton gave a brief account of *Rhipsalis*, a genus of the Cactaceæ whose members are pendulous from tree trunks or rocks. Most of these plants occur in tropical America, but a few species, strange to say, are found in tropical east Africa. Of the fifty-three species that have been recognized, the speaker discussed chiefly those of Mexico, Central America and the West Indies, illustrating his remarks with herbarium specimens.

Dr. Tracy Hazen described in detail an interesting phase in the development of a species of *Chætophora* found in the brook flowing through the herbaceous valley of the New York Botanical Garden. This investigation is, however, not yet complete. Dr. Hazen stated incidentally that the algal flora of this brook appeared to be considerably richer now than it was a few years ago, and a discussion followed as to the presence of additional forms, some attributing it to insects, frogs and other minor aquatic animals, and others to

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the wild ducks that frequent this brook through the summer season.

W. A. Murrill,
Secretary pro tem.

The club met at the American Museum of Natural History on November 10, 1908, and was called to order by Vice-president Burgess at 8:15 P.M. About 95 persons were present.

After the reading of the minutes of the meeting of October 29, Dr. N. L. Britton delivered the lecture of the evening on "Trees of the Vicinity of New York." The lecture was illustrated by lantern slides from the Van Brunt collection and was of a popular nature. The trees were taken up in a biological order, beginning with the gymnosperms, and the photographs exhibited illustrated both the general habit of the trees discussed and the details of their flowers and fruit.

Marshall A. Howe,
Secretary pro tem.

Section of Geology and Mineralogy of the New York Academy of Sciences

A regular monthly meeting of the section was held October 5 in the academy rooms at the American Museum of Natural History. Four papers were presented, as follows:

Outline of the Geology of Long Island, N. Y.: Professor W. O. Crosby.

Professor Crosby is of the opinion that the Pleistocene history of Long Island is relatively simple, and the known facts are accounted for by a single ice-invasion. The recent reference of the underlying lignitic and pyritic Chesapeake (Miocene) clays and the Lafayette (Pliocene) yellow gravel to the Pleistocene glacial series is believed to be a mistake. From the early Pleistocene uplift dates the cuesta of Long Island, to which Long Island Sound holds the relation of an inner lowland. This lowland is still floored by Cretaceous clays and sands. The transverse valleys and deep bays of the north shore of Long Island are essentially preglacial, though greatly modified by glacial erosion and deposition.

The Production of Low-grade Copper Ore in the West: Professor James F. Kemp.

The speaker presented a brief description of the recent development of the so-called "low-grade" copper mines in Bingham Cañon, Utah, and at Ely, Nev. By means of maps the geographical situation was made clear and the geological relations were outlined. The ores consist of bodies of silicified and brecciated porphyry, impregnated with chalcocite. They are mined by means of steam shovels, in huge open cuts. They range in copper from less than two to two and a half per cent. The operation and processes of the mills and smelters were briefly outlined. The paper was based upon visits made the past summer.

Limestones Interbedded with the Fordham Gneiss in New York City: Dr. Charles P. Berkey.

The discovery of beds of limestone at three points in such relation as to indicate interbedding with the banded gneisses was announced. This is an additional feature of similarity between the gneisses of the Highlands and the Fordham at its type locality. The largest bed is about 27 feet thick and is exposed in the east wall of the new Jerome Park Reservoir at 205th Street. In all cases these limestones are very impure and coarsely crystalline, carrying many unusual minerals arising chiefly from recrystallization. Chondrodite and actinolite are abundant. Sphalerite and galenite are also found.

Continental Formations of the North American Paleozoic: Professor A. W. Grabau.

The change of opinion in regard to conditions under which many of the well-known sedimentary formations are originally deposited was outlined. A tabulated list of those formations of the Appalachian region whose characters seem to indicate continental origin was exhibited and the evidence was briefly discussed. This article is to be published in full in Science.

Charles P. Berkey,
Secretary of Section

Washington Section of the American Chemical Society

The 185th meeting was called to order by President Walker on Thursday evening, November 12. The attendance was 90, this large number being due to the fact that many visiting members of the A. O. A. C. were present. The following papers were read:

"Color of Lead Chromate," E. E. Free.

"Absorption of CO_2 by Moist Oxide," W. O. Robinson.

"Solubility of Gold in Salt Solutions," W. J. McCaughey.

"The Distribution of $NaNO_3$ in the United States," C. E. Munroe.

Three members of the society were elected as councilors to the American Chemical Society, viz., L. M. Tolman, E. T. Allen and E. M. Chace.

J. A. LeClerc,
Secretary

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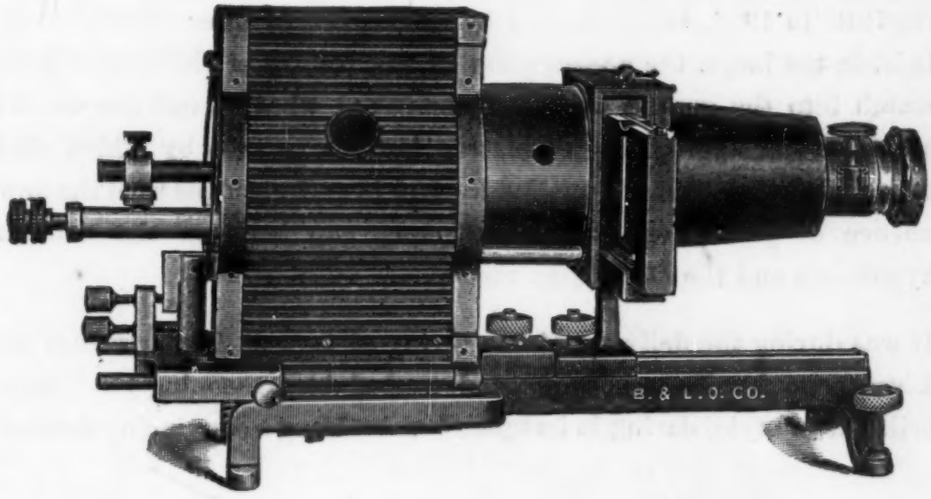

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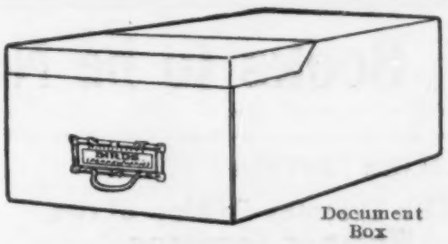

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